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USATECOM Project No. 8-8-0240-09
Report No. DPS-2929

FINAL REPORT ON

ENGINEER DESIGN TEST

OF

40-MM GRENADE LAUNCHER ATTACHMENTS FOR

M16A1 RIFLE (GLAD) (U)

BY

ERIC KEELE
GEORGE HENDRICKS

OCTOBER 1968

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USATECOM PROJECT NO. 8-8-0240-09

ENGINEER DESIGN TEST OF 40-MM GRENADE LAUNCHER ATTACHMENTS FOR M16A1 RIFLE (GLAD) (U)

FINAL REPORT

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(U) TABLE OF CONTENTS

(U) ABSTRACT

This test was conducted primarily to evaluate the characteristics of two prototype 40-mm grenade-launcher attachments for the M16/M16A1 rifle and to determine which was the better design for continued development. One launcher attachment was a pump-action design and the other was a pivot-action design. Additionally, as a portion of a continuing phase of the special-purpose individual weapon (SPIW) program, the 40-mm disposable barrel cartridge area target ammunition (DBCATA) concept was tested concurrently. The testing consisted of velocity, accuracy, reliability, adverse conditions, ruggedness, and lubricants compatibility tests. Testing began in May and was completed in August 1968. It was found that, on an over-all test basis, the functioning performance of the pump launcher was superior to that of the pivot and DBCATA launchers. Additionally, it was found that the test launchers, irrespective of type, were detrimental to the functioning performance of the rifle to which attached. The firing of the launcher caused the operating parts of the rifle to recoil out of position, resulting in rifle failures to fire and failures of the hammer to remain seared. On two occasions, the latter condition caused inadvertent firing of the rifle when an attached pivot launcher was fired. It was recommended that, of the three launcher designs tested, the design of the pump launcher be considered to offer the more feasible approach toward development of a suitable grenade launcher. It was also recommended that additional R and D efforts to improve the design of the DBCATA launcher be undertaken, if the system is to be further considered.

(U) FOREWORD

Materiel Test Directorate (formerly Development and Proof Services) was responsible for conducting the test and preparing the final report. The material for the test plan was provided by MTD, USAIB, BRL, and HEL with the Office of the Project Manager, Rifles (AMCPM-RS) responsible for over-all coordination of the test program.

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USATECOM PROJECT NO. 8-8-0240-09

FINAL REPORT ON ENGINEER DESIGN TEST OF 40-MM GRENADE LAUNCHER ATTACHMENTS FOR M16A1 RIFLE (GLAD) (U)

MAY TO AUGUST 1968

SECTION 1. INTRODUCTION (U)

1.1 (U) BACKGROUND

The grenade-launcher attachment development (GLAD) program is an evolution of a program which began several years ago to obtain a suitable 40-mm grenade-launcher attachment for use on the XM16E1 rifle (now the M16A1). In 1964, three types of prototype grenade-launcher attachments were subjected to military potential tests. All launcher designs were single-shot and fired the standard family of 40-mm grenade cartridges for the M79 launcher. The launcher now known as the XM148 proved to be the best design. Further development of the design was continued and production-models were manufactured.

In January 1967 a New Equipment Training Team arrived in Viet Nam and trained personnel in the care and use of the XM148 grenade launcher. At the same time, the Army Concept Team in Viet Nam (ACTIV) conducted an evaluation of the launcher and found it to be unsatisfactory for operational use in Viet Nam. Subsequently, the GLAD program was initiated and on 1 May 1968 Codes AA and AN Firms each delivered 20 prototype grenade-launcher attachments to the Army for engineer design tests which were conducted concurrently by the United States Army Infantry Board, Human Engineering and Ballistic Research Laboratories, and Materiel Test Directorate (formerly Development and Proof Services).

At this time, Code AA also delivered 20 launchers for the disposable barrel cartridge area target ammunition (DBCATA) concept

(hereafter referred to as the DBCATA launcher) for concurrent evaluation with the other two grenade-launcher attachments. The DBCATA program is a continuing phase of the special-purpose individual weapon (SPIW) program. The original requirement in the SPIW program was for a 3-shot semiautomatic launcher concept; however, the continuing program is now concentrating on a single-shot design that can be mounted on the M16A1 rifle or other standard weapons, as well as SPIW.

1.2 DESCRIPTION OF MATERIEL (U)

(C) The three grenade launcher types tested are of a single-shot concept designed for attachment to the M16A1 rifle and XM177E2 submachine gun. The Code AA and AN launchers are designed to fire the standard family of 40-mm grenade cartridges for the M79 launcher. The DBCATA is also 40-mm, but is designed to fire a unique ammunition, in that each cartridge is a disposable barrel. The propellant gases from firing are contained in a telescoping cup within the disposable barrel. This eliminates smoke and flash display and reduces the sound of firing. The cartridges are designed to utilize the 40-mm M407A1 practice and M406 HE projectiles of the family of ammunition for the M79 launcher.

(U) The Code AA launcher, hereafter referred to as the pump-launcher, is a hammerless, pump-operated mechanism with a forward moving barrel which is assembled to the underside of the launcher housing with a T-shaped track. The pumping action, or forward motion of the barrel, automatically recocks the mechanism and extracts the fired case, which is ejected forward and down by a spring-loaded ejector. Loading of the launcher is accomplished by inserting a round into the open breech with the barrel in the forward position and pulling the barrel rearward to the locked position. The safety is of the type which blocks the movement of the trigger. It is located forward of the trigger within the trigger-guard and is released by forward pressure of the trigger finger.

(U) A quadrant-type sight is featured with the pump launcher. The sight is adjustable in elevation and deflection independently of range settings and provides range selections from 50 to 400 meters, in 25-meter increments. The sight mounts on the underside of the carrying handle of the rifle (or submachine gun) and is readily removed by loosening the mounting screw. The right and left side views of a pump launcher attached to an M16A1 rifle and of the sight are shown in Figures 1.2-1 and 1.2-2.

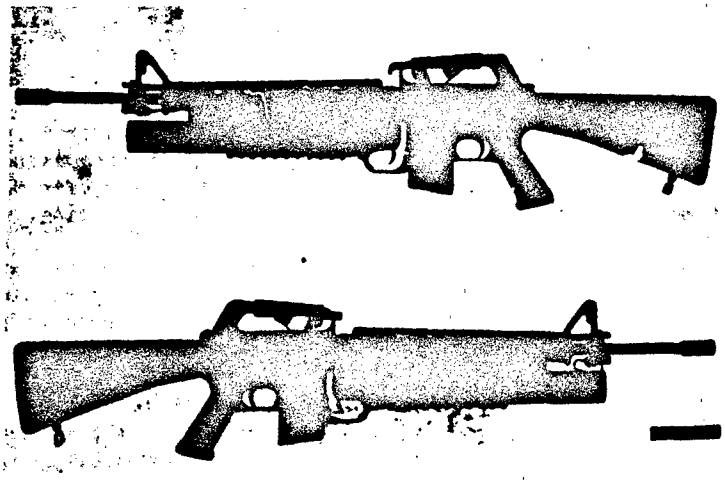


Figure 1.2-1 (U): Right and Left Side Views of the Pump Launcher Attached to the M16A1 Rifle (U).

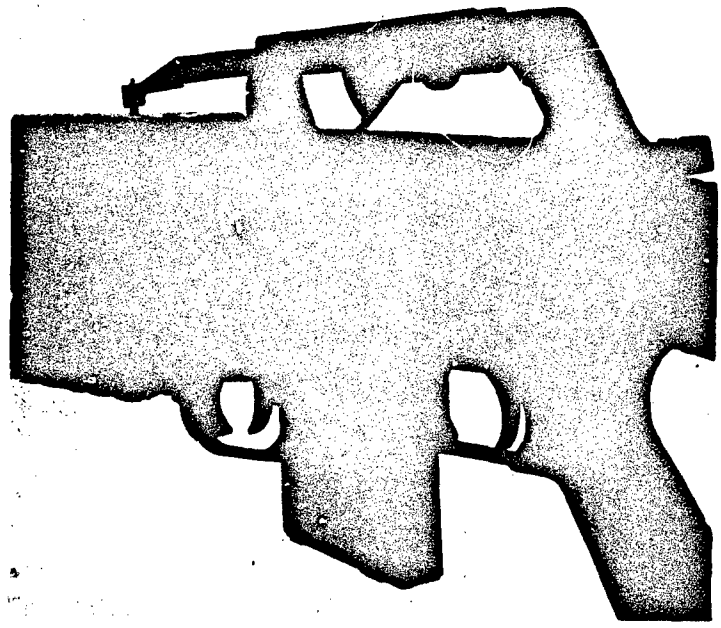


Figure 1.2-2 (U): Three-Quarter Rear View of the Primary Sight for the Pump and DBCATA Launchers (U).

(U) The Code AN launcher, hereafter referred to as the pivot launcher, features a barrel which pivots to the right or left on upper and lower trunnion pins. Opening of the breech is accomplished by depressing the cocking levers which cock the firing mechanism and release the barrel for manual pivoting. As the barrel is pivoted, ejection is performed automatically by a spring-loaded ejector sleeve which moves coaxially with the barrel. Loading of the launcher is accomplished by inserting a round into the breech, pushing forward on the base of the round with the heel of the hand to compress the ejector spring, and subsequently pivoting the barrel into the locked position. The firing mechanism is similar to that found in a single-action revolver with all moving parts on pivot pins. An access cover to the firing mechanism is provided on the right side of the launcher housing for inspection and maintenance. The safety is of the type which engages the sear and blocks movement of the sear and trigger. It is located forward of the trigger and can be actuated from either the right or left side of the launcher. Right and left side views of a pivot launcher attached to an M16A1 rifle are shown in Figure 1.2-3.

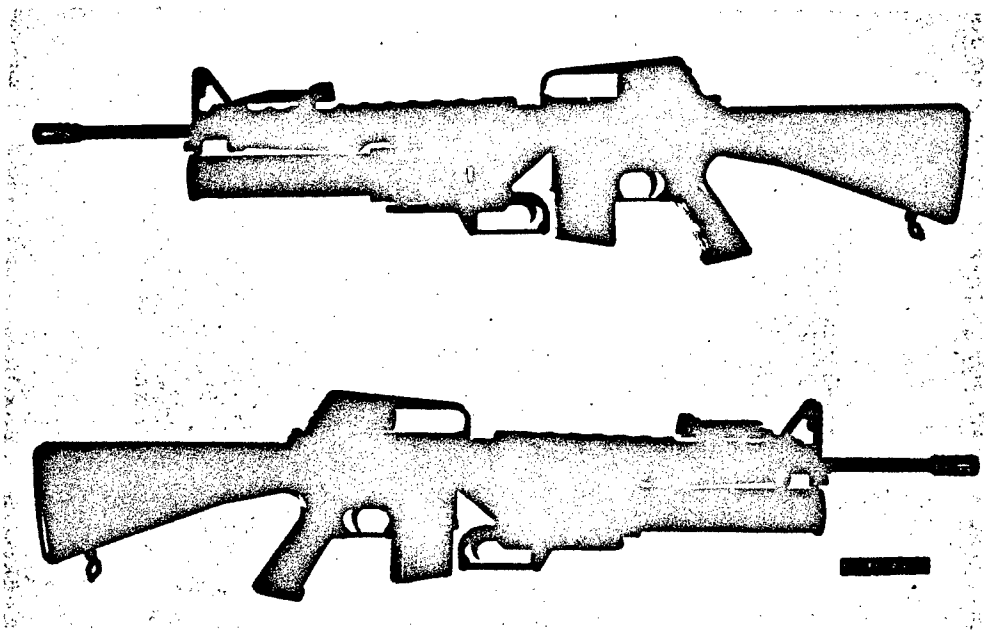


Figure 1.2-3 (U): Right and Left Side Views of the Pivot Launcher Attached to the M16A1 Rifle (U).

As with the pump-launcher, a quadrant-type sight is provided. The sight is adjustable in elevation and deflection independent of range settings and provides range selections from 50 to 375 meters, in 25-meter increments. The sight mounts at the rear of the carrying handle of the rifle (or submachine gun) and is readily removed by depressing a spring release on the back of the sight. In addition to the quadrant sight, a ladder-type sight which mounts on the top of the M16A1 rifle, directly behind the front sight, is provided for use as a battle sight. The sight is adjustable in elevation and deflection and is graduated from 50 to 250 meters in 50-meter increments. Views of the quadrant sight and the battle sight are shown in Figures 1.2-4 and 1.2-5.

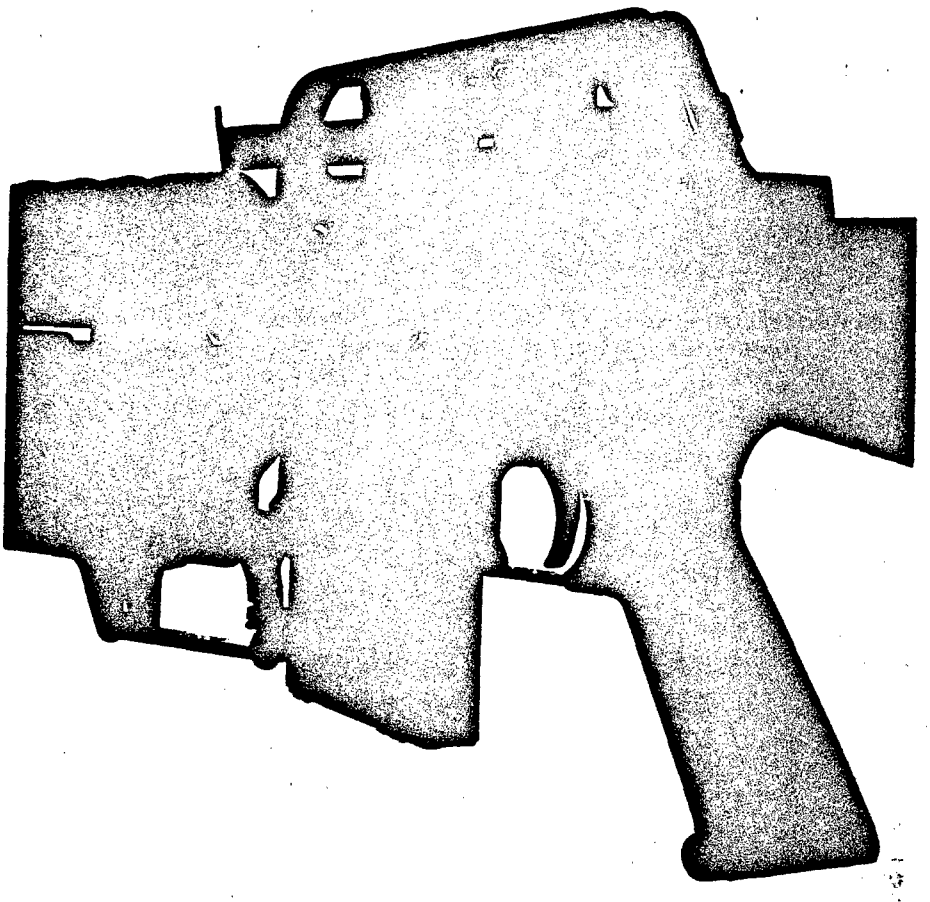


Figure 1.2-4 (U): Three-Quarter Rear View of the Primary Sight for the Pivot Launcher (U).

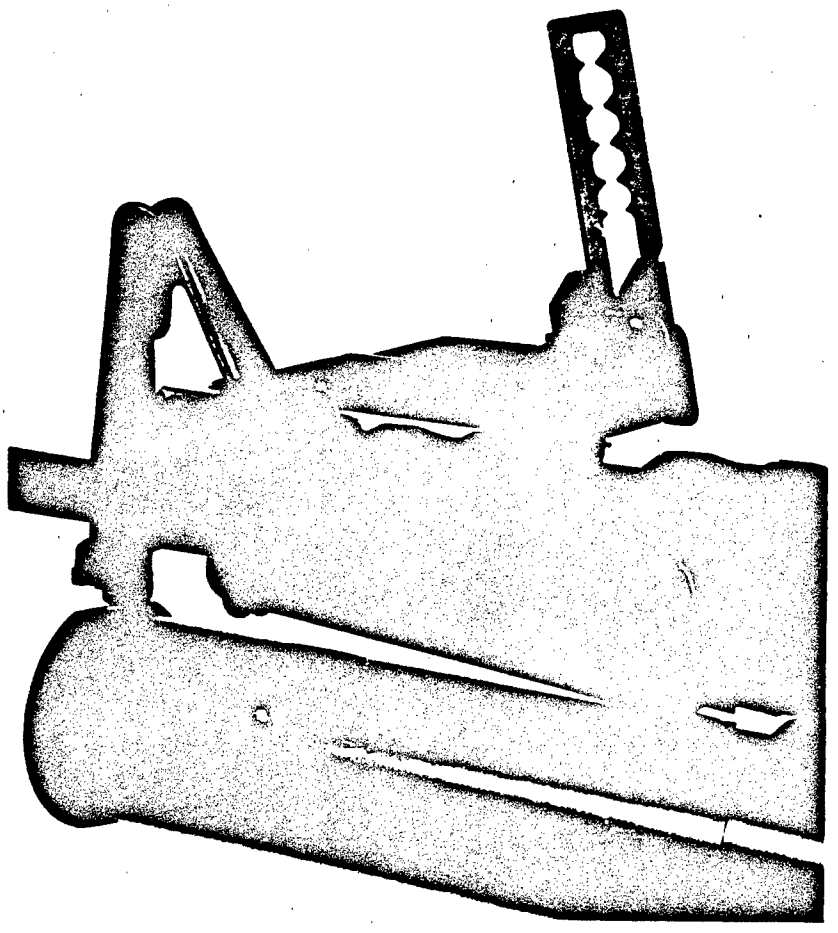


Figure 1.2-5 (U): Three-Quarter Rear View of the Battle Sight for the Pivot Launcher (U).

(C) The DBCATA launcher, in essence, is a launching platform in which the cartridge assembly, consisting of a disposable rifled barrel casing with a standard 40-mm projectile, is mounted for firing. When fired, the projectile is launched from the rifled casing, a piston-type primer in the casing forces the firing pin rearward to accomplish recocking of the firing mechanism, and the rifled casing is automatically ejected. The launcher is then ready for reloading which is accomplished by attaching another cartridge to the breech face. The safety on the DBCATA launcher is similar to that of the pump-launcher in that it is located forward of the trigger within the trigger-guard and blocks the movement of the trigger. Views of the right and left side of the DBCATA launcher assembled to the M16A1 rifle are shown in Figure 1.2-6.

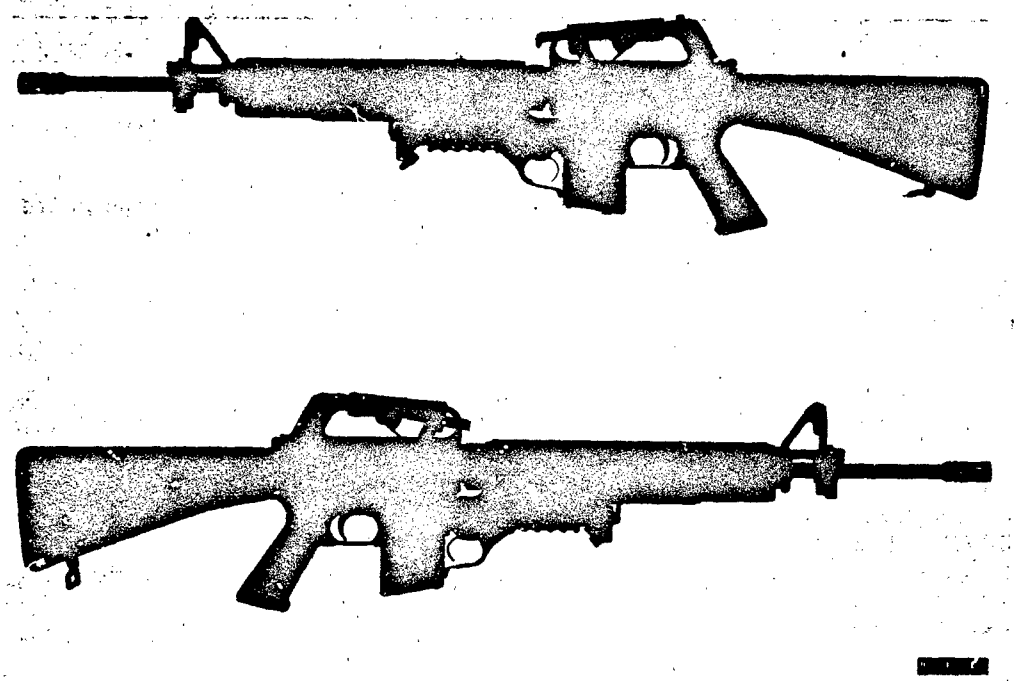


Figure 1.2-6 (U): Right and Left Side Views of the DBCATA Launcher Attached to the M16A1 Rifle (U).

(U) The sight provided for the DBCATA launcher is similar in desig. to that for the pump-launcher with the only difference being in the range graduations to compensate for the higher velocity of the DBCATA ammunition.

(U) The DBCATA launcher presently is not in contention with the pump and pivot launchers for immediate adoption, but is an R and D item. To provide a direct comparison of performance, however, the DBCATA was tested concurrently with the GLAD concepts.

1.3 (U) TEST OBJECTIVES

The test objectives were as follows:

a. To evaluate the functioning characteristics of the three grenade launcher attachments and determine which of the two GLAD concepts (pump or pivot) is the better launcher for continued development.

b. To determine if the launcher attachments meet the requirements of the technical characteristics for 40-mm grenade launcher attachments for rifles.

c. To evaluate the suitability of the grenade-launcher attachments for use with the M16A1 rifle and XM177E2 submachine gun.

1.4 SUMMARY OF RESULTS (U)

1.4.1 (U) Subtest Findings

1.4.1.1 Inspection. All three test launchers were readily attachable to the M16A1 rifle; however, the attachment of the launchers to the XM177E2 submachine gun required that modifications be made to the submachine gun for the pump and pivot launchers, and to both the submachine gun and launcher for attachment of the DBCATA. The attachment of the pump launcher added 2.7 lb to the weight of the rifle or submachine gun, the pivot launcher added 3.0 lb, and the DBCATA 2.3 lb.

A total of 95 individually manufactured parts was contained in the pump launcher, 97 in the DBCATA, and 150 in the pivot launcher. It should be noted that the 150 total for the pivot launcher included both a primary and battle sight. No battle sight was provided for the pump and DBCATA launchers. The battle sight for the pivot launcher contained 28 parts.

The operations required for care and maintenance of the test launchers were deemed not to be more difficult nor time-consuming than comparable operations on the M79 launcher. No special tools or cleaning equipment other than those used with the M79 launcher were required for operator maintenance of any of the three launchers.

1.4.1.2 Safety Examination. The launchers were safe to fire from the shoulder provided precautions for inherent features as discussed in par. 2.3.4 were observed.

The heat transferred to a grenade cartridge loaded in any of the test launchers, as a result of the rapid firing of the M16A1 rifle, was well below the cook-off point of the M406 HE round.

The calculated recoil energy of the pump and pivot launchers was 14 to 16 ft-lbs, depending upon which round of ammunition was being fired and whether the launcher was assembled to the M16A1 rifle or to the lighter XM177E2 submachine gun. The calculated recoil energy of the DBCATA launcher was 15 to 18 ft-lbs, again depending upon the weapon to which the launcher was attached. In comparison, the recoil energy of the M79 launcher was 22 to 24 ft-lbs.

1.4.1.3 Velocity and Accuracy. The average velocity was 243.4 fps for the pump launcher, 234.8 fps for the pivot launcher, and 252.9 fps for the DBCATA launcher. The round-to-round velocity variation with the test launchers was comparable. The average velocity for the M79 launcher with the same lot of ammunition used in the pump and pivot launchers was 235.7 fps.

The grouping characteristics of the M16A1 rifle were not adversely affected by attachment of any of the test launchers; however, attachment of the pivot launcher caused a shift in center-of-impact location with the rifle of approximately one mil. The sights on the rifle could be readjusted to compensate for the shift with latitude remaining for further adjustment. No sight adjustment was required with attachment of either the pump or DBCATA launchers.

Round-to-round dispersion of 40-mm ammunition with the pump and pivot launchers was comparable at all ranges. The sight on the pivot launcher was not correctly graduated for the velocity level produced by the launchers with the test lot of ammunition. Firings with the M79 launcher demonstrated that the M79 sights also did not match the test lot of ammunition, in approximately the same manner and to the same degree as the pivot launcher. It should be noted that the M79 and pivot launchers were comparable with regard to velocity level. The sights on the pump launcher were reasonably well matched to the test lot of ammunition; however, the pump launcher fired the test lot at a velocity approximately ten feet per second higher than did the M79 and pivot launchers. The battle sight provided for use with the pivot launcher also was not correctly graduated. The graduations on the sight for the DBCATA launcher were accurate at all ranges; however, the round-to-round dispersion was slightly greater than that of the pump and pivot launchers.

1.4.1.4 Adverse Conditions. The number of stoppages which occurred in the adverse conditions test are summarized in Table 1.4-I.

Table 1.4-I (U). Number of Stoppages in Adverse Conditions Tests (U)

Subtest	No. of Stoppages		
	Pump	Pivot	DBCATA
Low-temperature (-65°F)	[a]58	22	88
High-temperature (+155°F)	0	10	42
Static dust	0	10	8
Unlubricated	0	9	22
Water spray	0	29	5
Dynamic dust	0	21	18
Mud	0	23	[b] -
Salt-water immersion	0	31	9

[a]Fifty-four of the 58 stoppages were failures to extract. The extractors were modified after the low-temperature test.
[b]All three DBCATA launchers under test fired the initially loaded round, after which the sear would not release the firing pin because of mud between the contact surfaces. The test was terminated with all three launchers.

1.4.1.5 Reliability and Durability. The stoppage rates per 100 rounds fired for the three pump launchers throughout the 1000 rounds of firing were 3.8, 0.5, and 0.6; similarly, for the three pivot launchers the rates were 13.2, 11,3, and 22.3; and the rates for the DBCATA launchers were 2.8, 3.8, and 1.1.

The firing of 1000 rounds in the reliability test caused no degradation in the velocity performance of the pump or pivot launchers.

The extended use of any of the three types of launchers was not detrimental to the accuracy of the M16A1 rifle. However, the recoil imparted to the system from firing of the attached launcher adversely affected function performance of the M16A1 rifle in that failures to fire and failures of the rifle to remain seared, as described under pars. 1.4.2.1d and 1.4.2.2d, occurred throughout the reliability test.

1.4.1.6 Rifle Barrel Durability Test. Barrel-straightness tests disclosed that no permanent bending of the M16A1 rifle barrel occurred with the firing of an attached launcher with the rifle barrel hot from firing.

1.4.1.7 Ruggedness. The firing mechanisms on all three launchers withstood the impact of being dropped on hard-packed earth from a height of three feet. However, the sights on the pump and DBCATA launchers were rendered unserviceable when the weapons were dropped on the left side.

1.4.1.8 Solvents and Lubricants Compatibility. With the exception of insect repellent (type FSN 6840-558-0918), no detrimental effects from any of the various cleaners and lubricants were disclosed. The insect repellent dissolved the compound used to glue the handgrip to the barrel on the pump launcher.

1.4.2 (U) Deficiencies and Shortcomings

1.4.2.1 Deficiencies. Deficiencies were as follow:

a. Pump Launcher. The barrel-release latch on the pump launcher could be depressed accidentally by the gunner with rapid grasping of the handgrip on the launcher. This was a safety hazard in that live ammunition could be inadvertently ejected to strike on hard surfaces.

b. Pivot Launcher. Four instances of inadvertent firing of the the pivot launchers occurred. In each instance, the gunner pulled the trigger on the launcher and the hammer failed to fall, but, with subsequent slight movement of the barrel, the launcher fired. Further discussion of this deficiency is contained in par. 2.3.4.2a.

c. DBCATA Launcher. Deficiencies in this launcher included:

1) During the initial stages of the safety examination, attempts were made to load and fire a high-velocity 40-mm cartridge. No live cartridges could be assembled to the DBCATA launcher; however, a dummy round which was being used for display could be assembled. Specifications for rim dimensions of the M169 case for the high-velocity ammunition are 1.714-0.005 inch diameter before crimping and 1.725-inch maximum diameter after crimping. The drawings for the DBCATA launcher require the breech face to be 1.710-inch minimum to 1.714-inch maximum in diameter. On this basis, it is highly improbable, but not impossible, that a high-velocity round could be assembled to the DBCATA launcher. Since the live rounds available at APG could not be assembled, it was not determined whether the live rounds could be

fired if loaded in the DBCATA launcher.

2) The trigger group of the DBCATA launcher was of such design that the trigger could be partially pulled and when released would fail to return to the forward-position. In this partially pulled position, the launcher could not be put on safe, and in order to cause the trigger to return to the forward position, the gunner had to retract the charging handle. In some instances the gunner could push the trigger to the forward-position, but in so doing could cause the launcher to fire. The manufacturer attempted to correct the malfunction by installing a stronger primary-sear spring but this did not eliminate the problem.

3) It was possible for the DBCATA launcher to be fired inadvertently when a cartridge was assembled. One instance of such firing occurred when the gunner loaded the launcher during the reliability test. This was attributed to failure of the primary sear to engage the firing pin when the firing-pin-stop released the firing pin with loading of the round. This occurred during the early stages of the 1000-round reliability test and the launcher was modified with a stronger primary sear spring. No additional inadvertent firings occurred in the firing of 485 rounds.

4) The DBCATA launcher failed to operate after being subjected to the mud test; all three launchers in the test fired the initially loaded round, after which the sear would not release the firing pin because of mud between the contact surfaces.

d. All Launchers. The recoil imparted to the M16A1 rifle from firing the attached pivot or DBCATA launcher sometimes caused actuation of the trigger which allowed the hammer in the rifle to fall. In two instances this caused inadvertent firing of the rifle with the firing of an attached pivot launcher. Except when mounted in a solid rest and firing the XM576E1 shot-shell round which gives a higher impulse to the launcher than other 40-mm ammunition, trigger actuation of the M16A1 rifle with the recoil of the pump launcher did not occur. However, it appears that this should be considered as potentially possible at any time, depending upon the peculiarities of the individual rifle mechanism and circumstances.

1.4.2.2 Shortcomings. Shortcomings were as follow:

a. Pump Launcher. Shortcomings of the pump launcher include:

1) The barrel-bracket insulators used in the mounting brackets chipped and broke with use.

2) The safety on the pump launcher could not always be moved to the SAFE position when the launcher was in an unlubricated condition, after exposure to dust and mud, and after extended use of the launcher. The detent which positioned the safety extended out of the housing too far and then bound when an attempt was made to move the safety to the SAFE position. No problems were experienced in moving the safety from the SAFE to FIRE position.

3) The compound used to glue the handgrip to the barrel of the launcher was dissolved by insect repellent during the solvents and lubricants compatibility test. Additionally, on two occasions during other subtests, once in the hot test and once in the 1000-round reliability test, the handgrips on pump launchers loosened and had to be reglued.

4) The mounting screw of sights on the pump launcher continually loosened during the firing of the rifle and launcher, and if not retightened the sight would drop from the weapon. Additionally, the sight was very fragile in the front post and rear aperature mounting brackets and when in position the sight caught on clothing and equipment.

5) The coating on the parts within the trigger-housing, particularly the firing-pin spring, were not resistant to the deleterious effects of salt water.

b. Pivot Launcher. Shortcomings of this launcher include:

1) The shooter can very easily pinch his hand between the top of the ejector and the bottom edge of the handguard during the loading cycle.

2) The tension on the rear barrel bracket on the pivot launcher had to be readjusted each time the launcher was disassembled from the rifle. If the bracket were over-tightened, the firing pin would strike the cartridge primer high and the launcher barrel was difficult to pivot. If the bracket were too loose, the

muzzle end of the barrel would drop down and the firing pin would strike low on the primer.

3) The primary sight on the pivot launcher was loose on the mounting bracket and was very fragile. Several of the sights were eliminated from test because the flexible leaf spring which holds the front sight post developed small cracks around the front retaining rivet. This allowed the leaf spring to lose tension and not return the front sight post to position after a round was fired.

4) The primary sight changed in range setting with recoil from firing the launcher.

5) The design of the rear sight bracket on the primary sight was such that the slot in the bracket could easily be mistaken for the aperture. Use of the slot in the bracket as an aperture would cause the rounds to impact to the left of the target.

6) Water accumulation in the plunger assembly in the hammer created a hydrostatic condition within the assembly which retarded movement of the plunger and caused two failures to fire during the salt-water immersion test. This malfunction could be overcome by recocking the launcher, which depressed the plunger and forced the water from the assembly.

7) During the mud test, the function performance of the pivot launcher was very unreliable in that corrective action had to be continually applied to overcome malfunctions which were induced by the mud.

8) The frequency of occurrence of failures to eject throughout all tests with the pivot launcher severely degraded the reliability of the launcher.

9) The wear and deformation in the barrel-lock slot of one pivot launcher from firing 1000 rounds in the reliability test was such that excess movement of the barrel occurred when in the locked position. This movement was sufficient to cause off-center firing pin hits at the 3 and 9 o'clock positions on the primer, which, in turn, caused failures to fire.

c. DBCATA Launcher. Shortcomings of this launcher include:

1) The recoil from firing the DBCATA launcher continually caused the handguards to loosen from the spring-loaded retaining ring on the rifle.

2) Contact with the sling swivel in the forward part of the handgrip during recoil from firing the launcher caused damage to the shooter's knuckles.

3) Occasionally a telescoping cup ruptured with the firing of a round. On one occasion, the gunner's hand was singed.

4) The gunner can inadvertently grasp the assembled cartridge rather than the handgrip on the launcher.

5) The frequency of occurrence of failures to sear throughout all tests with the DBCATA launcher severely degraded the reliability of the launcher.

6) The sight changed range settings with recoil from firing the launcher.

7) The sight on the DBCATA and pump launchers were of the same design; therefore, the shortcoming relative to fragile construction and loosening of the sight on the pump launcher also applies to the DBCATA launcher.

8) The launcher sight housing stud, which positioned the sight on the M16A1 carrying handle, sheared on one sight during the reliability test.

9) The barrel-bracket insulators broke and chipped with use.

d. All Launchers. The bolt-carrier group in the M16A1 rifle and XM177E2 submachine gun moved rearward with the firing of the attached launcher and sometimes failed to return to the locked position. When this occurred, unless remedial action was applied to the rifle or submachine gun, failures to fire were experienced.

1.4.3 (C) Technical Characteristics (U)

Within the scope of the engineer design test the three grenade-launcher attachments complied with the requirements of the technical characteristics with the exception of the following:

a. The requirement that the launcher shall be so designed as to prevent chambering of a high-velocity round cannot be considered to have been met by the DBCATA launcher. Specifications for the maximum diameter of the breech on the DBCATA launcher and the minimum rim dimensions of the M169 cartridge case for high-velocity ammunition overlap. None of the high-velocity rounds at APG could be assembled to the DBCATA launcher; however, a dummy round which was being used for display could be assembled. Further discussion is contained in par. 2.3.4.

b. The requirements specify that the number of parts in the launcher attachments shall not exceed that of the M79 launcher, which is 106. The total number of parts in the pivot launcher was 150.

c. The sights on none of the launchers provided the precision and accuracy of adjustment comparable to that of the sights on the M79 launcher. The sights on the pivot and DBCATA launchers changed range settings with recoil of the launcher. Additionally, the sights on the DBCATA and pump launchers continually loosened during firing and if not retightened would drop from the weapon.

d. The configuration of the sights, particularly those on the pump and DBCATA, was such as to catch on clothing and equipment and location of the sight in the carrying handle of the rifle hindered carrying of the rifle.

e. It was desired that the launchers be equipped with a battle sight. Neither the pump or DBCATA launchers were provided with a battle sight.

f. The sights on the pump and DBCATA launchers failed to withstand being dropped from a 3-foot height on hard-packed earth, in that when the weapons were dropped on the left side the sights were rendered unserviceable.

g. The pivot launcher failed to function with any degree of reliability after being subjected to mud conditions. The DBCATA launcher would fire only one round after exposure to mud and thereafter failed to function.

h. The technical characteristics specify that the launcher attachment shall be capable of firing 1000 rounds without incurring broken or unserviceable parts. All three launcher attachments experienced either broken or unserviceable parts in the 1000-round reliability test.

1.5 (U) CONCLUSIONS

It is concluded that:

a. With respect to functioning performance in the over-all test the design of the pump launcher was superior to that of the pivot and DBCATA launchers (ref pars. 2.3 through 2.13).

b. In the present configuration, none of the primary sights are acceptable (ref pars. 2.2, 2.3, 2.13, and 2.15).

c. The recoil of any of the launchers, irrespective of type, is detrimental to the functioning performance of the M16A1 rifle or XM177E2 submachine gun (ref pars. 2.3, 2.6, and 2.13).

d. From the engineering standpoint, none of the three launchers met all of the requirements of the technical characteristics. However, the pump launcher was more acceptable in this respect than either of the other two designs (ref par. 1.4.3).

1.6 (U) RECOMMENDATIONS

It is recommended that:

a. Of the three launcher designs tested, the pump launcher be considered to offer the more feasible approach toward development of a suitable grenade launcher attachment.

b. Development efforts toward achievement of a rugged and reliable sight design be continued on the primary sight for the grenade-launcher attachment.

c. The battle-sight concept provided for use with the pivot launcher be adapted to the pump launcher.

d. If the DBCATA system is to be further considered, additional R and D efforts to improve the design of the launcher be undertaken.

e. In subsequent development, efforts be made to correct the detrimental effects of recoil forces on functioning performance of the rifle from firing of the launcher.

SECTION 2. DETAILS OF TEST (U)

2.1 (U) INTRODUCTION

The following subtests were designed to determine the performance characteristics of the test launchers and to assess the compatibility of the different model launchers with the M16A1 rifle and XM177E2 submachine gun. Due to the short supply of XM177E2 submachine guns; however, the M16A1 was used in most of the subtests with the XM177E2 being used only in one phase of the safety evaluation (par. 2.3) and in the launcher-accuracy phase (par. 2.4). The M79 grenade launcher was fired in the velocity, accuracy, and extreme hot and cold tests for control purposes.

The criteria for the individual subtests are based on the technical characteristics for 40-mm grenade-launcher attachments for rifles (Reference 2).

With the exception of the extreme cold and unlubricated tests, the launchers and rifles were lubricated with MIL-L-46000A, semifluid lubricating oil throughout the test. The weapons were lubricated with MIL-L-14107 lubricant in the extreme cold test.

Individual subtests were conducted in the same order as presented in the following pages. Twelve launchers were initially inspected and fired for velocity. Thereafter, three of each type were programmed for adverse conditions tests; two were fired for dispersion and accuracy, and three were fired 1000 rounds each in the reliability and durability tests. The remaining four launchers were employed in the ruggedness and rifle barrel durability tests, and by the Ballistic Research Laboratories (BRL).

All M16A1 rifles used in this test were assembled with the redesigned buffer; the barrels did not have chrome-plated chambers. The XM177E2 submachine guns were of the latest product-improved models on hand at APG. The lot of ammunition fired in the rifles in all subtests was cartridge, 5.56-mm, ball M193, lot TW-18249.

The types and lots of 40-mm ammunition employed throughout the test are listed in the test data.

The abbreviations used throughout the test in the recording of function data are given in Table 2.1-I.

Table 2.1-I (U). Abbreviations (U)

Abbreviation	Definition
	Launcher Malfunctions
CLF	Cocking levers failed to return to the normal position. This malfunction pertains only to the pivot launcher.
FFRL	Failure to fire, launcher.
FJ	Failure to eject.
FX	Failure to extract.
FER	Failure of the ejector to return after the barrel was pivoted into position. This malfunction pertains only to the pivot launcher.
FRT	Fired on release of trigger.
IAVF	Inadvertent fire.
PPO	Partial punch out of primer.
PS	The projectile stuck in the bore of the launcher. This malfunction occurred only in the extreme cold test.
RTC	Ruptured telescoping cup. This malfunction pertains only to the DBCATA launcher.
	Rifle Malfunctions
FBR	Failure of the bolt-carrier group in the M16A1 rifle to remain to the rear after firing the last round from the magazine.
FTR	Failure of the trigger to return to the forward position after release.
FF	Failure of a live round to be successfully stripped from the magazine and fully chambered.
BOB	Bolt over-rode the base of the round.
F2R	Fired two rounds on a single trigger pull in the semi-automatic mode.

Table 2.1-I (Cont'd)

Abbreviation	Definition
FFRR	Failure to fire, rifle. This malfunction of the rifle was due to the bolt-carrier group being recoiled rearward with the firing of the launcher.
FRRS	Failure of the rifle to remain seared. This malfunction of the rifle was due to actuation of the trigger from recoil of the launcher which allowed the hammer to fall.
Satis	Satisfactory performance.

2.2 INITIAL INSPECTION (U)

2.2.1 (U) Objectives

The objectives were:

a. To determine the completeness and serviceability of the test launchers.

b. To determine the physical characteristics of the test launchers and record measurements deemed necessary for reference during test.

2.2.2 (C) Criteria (U)

It is required that:

a. The launcher shall be suitable for attachment to the following point-fire weapons:

1) Rifle, 5.56-mm, M16/M16A1.

2) Submachine gun, 5.56-mm, XM177E2.

b. The launcher shall be of minimum length consistent with meeting other requirements. It is required that the over-all length of the assembled weapon-launcher combination, with launcher loaded and prepared for firing, not exceed the length of the point-fire weapon to which the launcher is attached.

c. The weight of the assembled weapon-launcher combination (without ammunition), including the launcher sight, shall not exceed the weight of the empty point-fire weapon alone by more than three pounds.

d. The launcher shall provide sufficient firing-pin energy to assure reliable functioning of the primer in the family of ammunition for the M79 grenade launcher.

e. The number of parts in the launcher and sight combined not exceed the number in the M79 launcher with sight.

f. The operations required for care and maintenance shall not be more difficult or time-consuming than the comparable operations required by the M79. The launcher and launcher sight assembled to the rifle shall be compatible with cleaning and maintenance requirements of the rifle.

g. The configuration and mounting arrangements of the launcher and sights will be such as to minimize catching on brush, vines, and equipment or clothing when the rifle-launcher combination is carried and used in a normal manner.

h. Not more than one special tool will be required for operator maintenance, and that this tool will weigh not more than 0.25 pound. Also, not more than one additional special tool will be required by armor personnel at organizational level for the attachment, removal and organizational maintenance of the launcher.

i. The launcher will be provided with a fully adjustable sight incorporating the following features:

   1) Permits convenient firing of the launcher at all ranges from 30 meters to approximately 400 meters.

   2) Permits zeroing of the launcher in both elevation and deflection, independent of the scale for adjustment of range.

   3) Provides precision and accuracy of adjustment substantially equal to that of the sights on the M79 launcher.

   4) Does not change adjustment in elevation or deflection in consequence of recoil from firing either the launcher or the point-fire weapon to which it is attached.

j. It is desired that the launcher sighting system also incorporate the following features:

   1) Provide a "battle sight" for the launcher, centrally located atop the point-fire weapon, so designed and constructed as to cause no significant inconvenience if left in place at all times when the launcher is assembled to the point-fire weapon.

2) The "battle sight" shall provide for firing elevations up to approximately 16 degrees so as to permit accurate aiming for ranges of 50, 100, 150, 200, and 250 meters.

2.2.3 (U) Method

One of each model of the test launchers was disassembled and an examination made of all parts. Each model launcher was photographed and the number of parts recorded.

The functioning of operating parts was checked manually on all launchers tested. The following measurements were recorded:

a. Weight of complete launcher system.

b. Weights of various groups of launcher system.

c. Firing-pin protrusion.

d. Firing-pin energy. (Copper crusher cylinders and a holding fixture designed for the M79 grenade launcher were employed with the pump and pivot launchers. No established method is yet available for the DBCATA launchers; therefore, firing-pin energy was not determined.)

e. Trigger pull.

f. Barrel bore measurements.

2.2.4 Results (U)

(U) The recorded weights and measurements for the three launcher types are given in Tables 2.2-I, -II, and -III. Disassembled views of the launchers and sights are in Figures 2.2-1 through -6. Barrel-bore and firing-pin measurements for all pump and pivot launchers are contained in Appendix I. Bore measurements of one rifle casing for the DBCATA launcher are also contained in Appendix I.

Table 2.2-I (U). Weights and Measurements of the Pump Launchers (U)

	Serial No.											
	8	9	10	11	12	13	14	15	16	17	18	20
M16A1 rifle with launcher attached (both empty, but with sling and magazine), lb	9.94	9.87	9.86	9.89	9.92	9.93	9.90	9.87	9.95	9.93	9.93	9.91
Primary sight assembly, lb	0.26	0.26	0.27	0.27	0.27	0.26	0.27	0.26	0.27	0.26	0.27	0.26
Barrel assembly, lb	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.93	0.94	0.93	0.94	0.92
Handguard, lb	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.39	0.38	0.38	0.38
Housing assembly (includes barrel bushings, barrel clamp, and mounting screws), lb	1.54	1.53	1.52	1.53	1.54	1.54	1.53	1.53	1.53	1.54	1.54	1.54
Bayonet bracket (spare assembly), lb[a]	0.14											

[a]A spare assembly was weighed as removal of the bracket from the M16A1 rifle required the disassembly of the flash suppressor from the rifle. The weight includes the sling swivel.

Table 2.2-I (Cont'd)

	Serial No.											
	8	9	10	11	12	13	14	15	16	17	18	20
Trigger pull (average of 5 trials), lb	6.0	6.5	6.1	7.6	6.3	5.7	7.9	6.2	6.8	7.2	8.1 [b]	-
Firing pin protrusion, in.	0.063	0.062	0.065	0.061	0.063	0.060	0.065	0.072	0.057	0.062	0.062	0.067
Firing pin indent, in.[c]	0.0111 [d]	-	0.0098	0.0107	0.0113	0.0103	0.0109	0.0110	0.0115	0.0119	0.0117	0.0117
Firing pin energy, in.-oz[c]	30.5 [d]	-	23.5	28.5	32.0	26.0	29.5	30.0	33.0	35.0	34.5	34.5
Recoil energy, ft lbs[e]	14 to 16											

Number of parts	
Total	95
Primary sight	27
Handguard	9
Launcher assembly	55
Bayonet holder	4

[b] The trigger-pull data were inadvertently omitted prior to transfer of this launcher to BRL.
[c] The copper crusher cylinders were indented at APG and forwarded to AMSWE-RDSR for measurements and determination of firing-pin energy. Five copper crushers were indented with each launcher.
[d] The barrel could not be locked with the M79 copper-crusher gage in the chamber.
[e] The recoil energy is dependent upon which round of ammunition is being fired and whether the launcher is assembled to the M16A1 rifle or the XM177E2 submachine gun.

Table 2.2-II (U). Weights and Measurements of the Pivot Launchers (U)

	Serial No.											
	02	03	04	05	06	07	08	09	10	11	12	13
M16A1 rifle with launcher attached (both empty, but with sling and magazine), lb	10.25	10.18	10.23	10.29	10.26	10.23	10.26	10.20	10.21	10.21	10.22	10.26
Primary sight assembly, lb	0.30	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Battle sight assembly, lb	0.22	0.22	0.22	0.22	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Barrel, lb	0.77	0.77	0.77	0.77	0.76	0.77	0.77	0.77	0.76	0.76	0.77	0.77
Handguard, lb	0.39	0.39	0.40	0.40	0.40	0.40	0.38	0.39	0.40	0.40	0.40	0.40
Housing assembly (includes barrel clamps, mounting screws, ejector housing, and ejector spring, but not the barrel), lb	1.79	1.80	1.78	1.79	1.79	1.79	1.79	1.78	1.79	1.78	1.78	1.79
Bayonet bracket (includes M16A1 sling swivel), lb	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Table 2.2-II (Cont'd)

	Serial No.											
	02	03	04	05	06	07	08	09	10	11	12	13
Trigger pull (average of 5 trials), lb	13.5	13.7	13.8	10.7	11.7	12.0	12.8	12.4	11.7	10.7	12.7	12.9
Firing pin protrusion, in.	0.052	0.072	0.070	0.069	0.065	0.064	0.056	0.064	0.054	0.055	0.066	0.076
Firing pin indent, in.[a]	0.0140	0.0131	0.0154	0.0143	0.0155	0.0169	0.0153	0.0138	0.0151	0.0152	0.0157	0.0155
Firing pin energy, in.-oz[a]	48.5	42.5	59.0	50.5	60.0	71.0	58.2	47.0	56.5	57.5	61.5	60.0
Recoil energy, ft lbs	14 to 16											
Number of parts												
Total	150											
Primary sight	34											
Battle sight[b]	28											
Handguards[c]	14											
Launcher assembly	74											

[a]The copper crusher cylinders were indented at APG and forwarded to AMSWE-RDSR for measurements and determination of firing-pin energy. Five copper crushers were indented with each launcher.
[b]The bayonet holder was part of the battle sight assembly and is included in this total.
[c]The handguards were modified M16A1 rifle handguards.

Table 2.2-III (U). Weights and Measurements of the DBCATA Launcher (U)

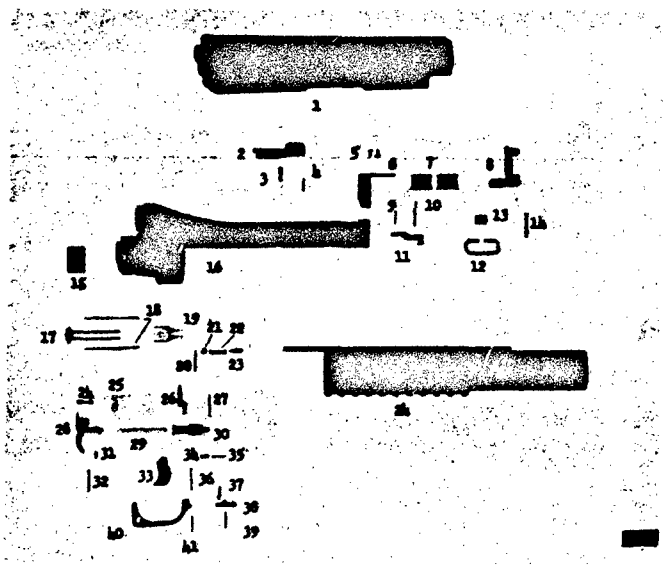
	Serial No.											
	8	9	10	11	12	13	14	15	16	17	18	19
M16A1 rifle with launcher attached (both empty, but with sling and magazine), lb	9.50	9.48	9.47	9.56	9.48	9.42	9.50	9.49	9.47	9.46	9.44	9.50
Primary sight assembly, lb	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.26	0.26	0.26	0.26	0.26
Housing assembly (includes handguard as it is an integral part of launcher, also barrel bushings, clamps and screws), lb	2.44	2.44	2.44	2.44	2.45	2.44	2.44	2.44	2.44	2.45	2.44	2.44
Handguard, lb	0.76	0.76	0.77	0.76	0.77	0.76	0.76	0.76	0.77	0.76	0.76	0.76
Bayonet bracket (spare assembly), lb[a]	0.11											

[a]A spare assembly was weighed as removal of the bracket from the M16A1 rifle required the disassembly of the flash suppressor from the rifle. The weight includes the sling swivel.

Table 2.2-III (Cont'd)

	Serial No.											
	8	9	10	11	12	13	14	15	16	17	18	19
Trigger pull (average of 5 trials), lb	8.0	7.1	7.5	8.5	8.9	5.5	4.8	5.5	5.3	5.7	4.8	[b]
Recoil energy, ft lbs	15 to 18											
Number of parts												
Total[c]	97											
Primary sight	27											
Handguard	20											
Launcher assembly	47											
Bayonet holder	3											

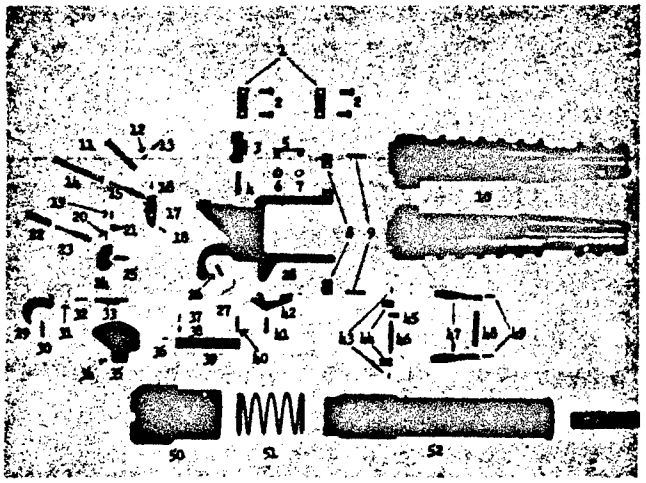
[b]The trigger-pull data were inadvertently omitted prior to transfer of the launcher to BRL.
[c]The number includes the parts which make up the firing-pin stop. The firing-pin stop was a modification which was made to the DBCATA launcher in the reliability test, and is shown in Figure 2.13-1.



Parts List for Pump Launcher

No.	Identification	No.	Identification
1	Handguard	21	Ejector retainer
2	Barrel release latch	22	Ejector spring
3	Barrel release latch pin	23	Ejector
4	Barrel release latch spring	24	Sear spring
5	Barrel bracket screws (2 ea)	25	Secondary sear
6	Barrel bracket	26	Cocking lever
7	Barrel insulators (2 ea)	27	Cocking lever pin
8	Bayonet bracket	28	Trigger
9	Barrel retaining latch spring	29	Firing-pin spring
10	Barrel retaining latch pin	30	Firing pin
11	Barrel retaining latch	31	Trigger bushing
12	Sling swivel	32	Trigger pin
13	Button swivel	33	Safety
14	Sling swivel screw	34	Safety detent
15	Backplate	35	Safety detent spring
16	Housing assembly	36	Safety retainer pin
17	Follower plate	37	Extractor spring
18	Follower springs (2 ea)	38	Extractor
19	Follower	39	Extractor pin
20	Ejector retainer pin	40	Trigger guard
		41	Trigger guard pin

Figure 2.2-1 (U): Disassembled View of Pump Launcher (U).



Parts List for Pivot Launcher

No.	Identification	No.	Identification
1	Barrel bracket (2 ea)	27	Sear pivot spring
2	Barrel bracket screws (4 ea)	28	Housing assembly
3	Rear mount bracket	29	Trigger
4	Spring pin	30	Trigger pin (spring pin)
5	Barrel stop link	31	Ball bearing
6	Roller	32	Sear spring
7	Retaining ring	33	Sear
8	Trunnion pin (2 ea)	34	Cover screw
9	Trunnion pin retainers (2 ea spring pins)	35	Cover
10	Modified M16A1 handguards	36	Spring pin
11	Adapter pivot pin for M16A1 rifle	37	Plunger spring
12	Detent plunger	38	Trigger guard plunger
13	Detent spring	39	Trigger guard
14	Cocking arm spring	40	Spring pin
15	Cocking arm spring guide	41	Spring pin
16	Dowel pin	42	Barrel lock
17	Cocking arm	43	Spring pin (2 ea)
18	Dowel pin	44	Safety levers (2 ea)
19	Dowel pin	45	Detent spring
20	Firing-pin spring	46	Safety shaft
21	Firing pin	47	Cocking lever (2 ea)
22	Hammer spring	48	Cocking shaft
23	Hammer spring guide	49	Spring pin (2 ea)
24	Hammer	50	Ejector
25	Plunger assembly	51	Ejector spring
26	Trigger return spring	52	Barrel

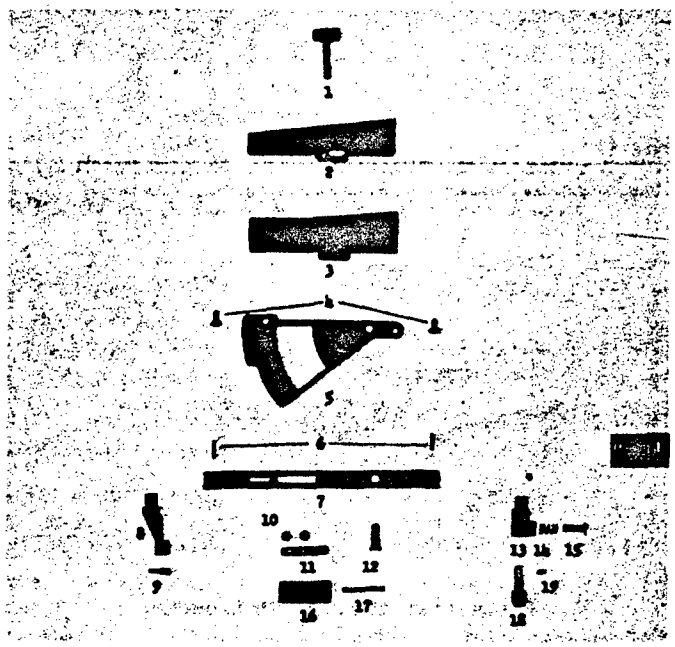
Figure 2.2-2 (U): Disassembled View of Pivot Launcher (U).

Parts List for DBCATA Launcher

No.	Identification	No.	Identification
1	Handguard (left side)	22	Roll pin for bayonet bracket
2	Handguard (right side)	23	Primary sear
3	Handgrip retainer screws (4 ea)	24	Primary sear spring
4	Handgrip (left side)	25	Sear bushing
5	Handgrip (right side)	26	Safety retainer pin
6	Rear barrel bracket	27	Sear spring
7	Rear barrel bracket screw and nut	28	Semiautomatic sear
8	Front barrel bracket	29	Charging handle
9	Rear barrel bracket insulators	30	Trigger spring
10	Front barrel bracket insulators	31	Trigger
11	Front barrel bracket screws (2 ea)	32	Trigger pin
12	Pins for round retainers (2 ea)	33	Safety
13	Front mount block	34	Primary sear pin
14	Guide pin	35	Trigger housing[a]
15	Firing pin spring	36	Round retainer return springs (2 ea)
16	Firing pin	37	Round retainer (left side)
17	Housing assembly	38	Round retainer (right side)
18	Breech buttons (2 ea)	39	Button swivel
19	Breech button screws (2 ea)	40	Sling swivel screw
20	Bayonet bracket (left side)	41	Sling swivel
21	Bayonet bracket (right side)		

[a]Housing contains the safety detent and spring.

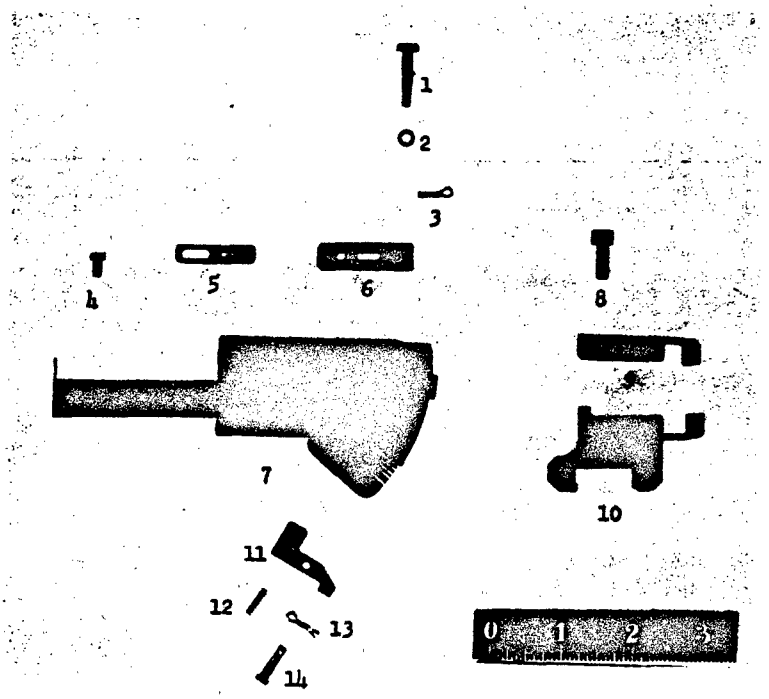
Figure 2.2-3 (C): Disassembled View of DBCATA Launcher (U).



Parts List for Sight on Pump and DBCATA Launcher

No.	Identification
1	Mounting screw
2	Sight base mount (right side)
3	Sight base mount (left side) (2 pieces)
4	Sight base retaining screws (2 ea)
5	Sight base
6	Roll pins for sight brackets (2 ea)
7	Sight arm assembly (5 pieces)
8	Front sight bracket
9	Post sight
10	Latch spring retainer screws
11	Latch spring
12	Pivot screw
13	Peep sight bracket
14	Peep sight retainer spring
15	Retainer
16	Range selector latch
17	Range selector latch spring
18	Peep sight
19	Retainer pin

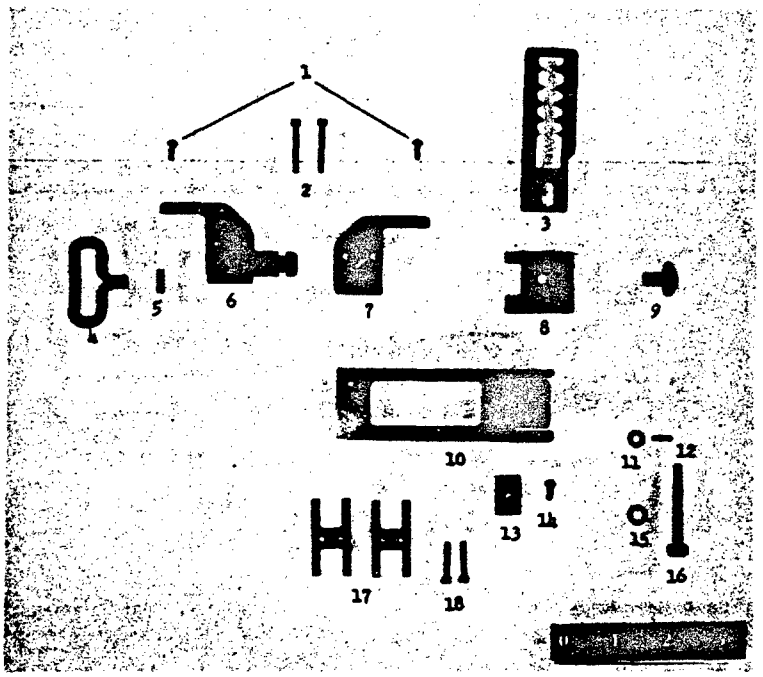
Figure 2.2-4 (U): Disassembled View of Sight for Pump and DBCATA Launcher (U).



Parts List for Primary Sight on the Pivot Launcher

No.	Identification
1	Elevation adjustment screw
2	Washer
3	Cotter pin
4	Windage adjustment screw
5	Peep sight
6	Peep sight base
7	Primary sight base
8	Sight base screw
9	Sight base mount (right side)
10	Sight base mount (left side)
11	Detent lever
12	Spring
13	Cotter pin
14	Detent lever pivot pin

Figure 2.2-5 (U): Disassembled View of the Primary Sight for the Pivot Launcher (U).



Parts List for Battle Sight on the Pivot Launcher

No.	Identification
1	Sight mount base screws (2 ea)
2	Front clamp screws (2 ea)
3	Sight leaf
4	Sling swivel
5	Sling swivel spring pin
6	Front clamp (right side)
7	Front clamp (left side)
8	Sight base
9	Elevation adjustment screw
10	Sight mount base
11	Retainer washer
12	Spring pin
13	Rear mount base
14	Rear mount base screw
15	Washer
16	Windage adjustment screw
17	Rear clamp (2 ea)
18	Rear clamp screws (2 ea)

Figure 2.2-6 (U): Disassembled View of Battle Sight for the Pivot Launcher (U).

2.2.5 (C) Analysis (U)

With the exception of the following, the launchers met the requirements of the technical characteristics as outlined under the criteria, paragraph 2.2.2.

a. The primary sights furnished with the test launchers did not provide precision and accuracy of adjustment equal to that of the sights on the M79 launcher. Also, the sights were subject to catching on clothes and equipment, particularly those on the pump and DBCATA launchers.

b. The primary sights on both the pivot and DBCATA launchers changed range setting with recoil of the launcher.

c. No battle sights were provided for use with the pump or DBCATA launchers.

d. The total number of parts in the pivot launcher with both primary and battle sight exceeded the specified limit by 44 parts.

e. The attachment or removal of the pump and DBCATA launchers to the XM177E2 submachine gun required operations above that specified for organizational level.

All three launcher types were readily attachable to the M16A1 rifle. The launchers could be attached to the XM177E2 submachine gun, but modifications were required either to the submachine gun, the launcher or both. The attachment of the pump launcher to the XM177E2 required removal of the front handguard cap and the handguard slip ring which entailed removal of the front sight from the submachine gun. Additionally, a collar which assembled over the rear of the muzzle suppressor on the XM177E2 was required for the front mounting bracket of the launcher. The pivot launcher was readily attached to the XM177E2, but with the launcher attached, the handguard for the XM177E2 could not be assembled and no special handguard was provided. The DBCATA launcher, as with the pump, required removal of the handguard cap, but not the handguard slip ring. Additionally, a special front-mount block for the launcher was required. The special block was cut away to accommodate the bottom of the front sight on the XM177E2.

The attachment of the pump launcher added 2.7 lb to the M16A1 rifle, attachment of the pivot launcher added 3.0 lb, and the DBCATA added 2.3 lb.

The over-all weapon length with launchers assembled to the rifle or submachine gun, with launcher loaded and prepared for firing, did not exceed that of the weapons without launchers attached.

During the safety certification, it was revealed that the upper frame of the pivot-action launcher was structurally weak and subject to deformation which allowed the muzzle end of the barrel to drop down approximately 0.2 inch. With the barrel in such a position, the firing pin would strike the primer low and off-center, causing failures to fire. All pivot-action launchers were returned to the manufacturer for correction. The manufacturer modified the launcher housing by adding a rear barrel bracket (Figure 2.2-2, part No. 3). This corrected the problem of the weak frame, but subsequently created a second problem in that each time the launcher was disassembled the tension on the rear bracket had to be adjusted. If the bracket was too tight, the firing pin would strike the primer high and the launcher barrel was difficult to pivot. If the bracket was too loose, the muzzle dropped down and caused the firing pin to strike low on the primer, the problem originally encountered prior to installation of the rear bracket.

The requirement that the launcher provide sufficient firing-pin energy to assure reliable functioning of the primer in the family of ammunition for the M79 grenade launcher could not be determined because of the frequency of misfires inherent in the ammunition lot provided for test. Both the pump and pivot launchers experienced failures to fire during test, particularly in the extreme-cold and reliability tests. Inspection of the failures to fire disclosed defective ammunition with respect to propellant and primers. Further discussion of the problems is contained in paragraphs 2.5.4 and 2.13.4.

The total numbers of parts in the pump and DBCATA launcher with sights were both less than the 106 parts contained in the M79 launcher. The total of 150 parts reported for the pivot launcher included both a primary and a battle sight. If the battle sight were excluded, the total decreased to 122 or, if the battle sight were included and the primary sight excluded, the total became 114, which in either instance exceeded the requirement of 106 or less.

The operations required for care and maintenance were deemed not to be more difficult nor time-consuming than comparable operations on the M79 launcher. In the opinion of maintenance personnel, the DBCATA was the easiest maintained, the pump next, and the pivot and M79 were comparable. No special tools other than the cleaning equipment for the M79 launcher were required for operator maintenance of any of the three launchers. The attachment and removal of the launchers to or from the M16A1 rifle required no special tools. However, as previously stated, attachment of the pump and DBCATA launchers to the XM177E2 submachine gun required removal of the front sight from the submachine gun, which is above organizational-level maintenance.

Each launcher was provided with a primary sight which was adjustable in elevation and deflection independent of the scale for selection of range. However, the precision and accuracy and means of adjustment of the sights were not equal to that of the sights on the M79 launcher.

All of the launcher sights were graduated in increments of 25 meters with the sights on the pump and DBCATA having range selections from 50 to 400 meters and those on the pivot launcher from 50 to 375 meters. The sights for all three launcher types assembled to the rifle carrying handle were easily removed for storage when not in use. None of the sights changed adjustment in elevation or deflection (independent of range-selection setting) with recoil from firing the launcher or rifle. However, the sights on the DBCATA and pivot launchers were subject to changes in range setting with recoil from firing the launcher and the sights on the pump and DBCATA would loosen at the mounting screw, and if not retightened would drop from the weapon. The sights are shown in Figures 1.2-2 and 1.2-4.

No tests were conducted at APG to determine if the design of the launchers was such as to minimize catching on brush or vines, but it was found that the primary sights on all three launcher types were very susceptible to catching on clothes and equipment. Additionally, the sights on the pump and DBCATA launchers were very fragile in the brackets for attachment of the front and peep sight to the sight-arm assembly.

A battle sight which mounted on top of the M16A1 rifle was provided with the pivot launcher. The sight was adjustable in deflection and elevation and was graduated in 50-meter increments from 50 to 250 meters. The design of the sight was such that it did not interfere with the carrying or operation of the rifle if left in position at all times. The sight is shown in Figure 1.2-5. A battle sight was not provided for use with the pump or DBCATA launcher.

2.3 SAFETY EXAMINATION (U)

2.3.1 (U) Objective

The objective was to establish that the test launcher - rifle combinations (all models) are safe to operate and fire from the shoulder, and to provide information necessary for a safety release of the test launchers by USATECOM for service tests.

2.3.2 (C) Criteria (U)

It is required that:

a. The launcher be secure against accidental discharge from rough handling when carried loaded and with the safety in the SAFE position.

b. The safety (or safeties) be so designed and located as to be easily identifiable, quickly and conveniently disengaged at will, and reasonably secure against accidental disengagement. The operation shall be so arranged that the SAFE and FIRE positions of the safety can be quickly and easily distinguished, both by sight and by touch while using necessary protective clothing to include temperate winter clothing.

c. The launcher be secure against accidental discharge by a firer assuming any of the standard firing positions rapidly, with the weapon loaded and the safety disengaged (in FIRE position). This condition shall be considered to be met if the launcher withstands, without firing, a vertical free drop of the rifle - launcher assembly butt-downward, from a height of five feet, impacting on a surface of hard-packed earth.

d. The launcher be suitable for safe and effective firing of the various types of 40-mm ammunition, listed below:

1) Cartridge, HE, 40-mm, M406.

2) Cartridge, practice, 40-mm, M407.

3) Cartridge, proof, 40-mm, XM387E3.

4) Cartridge, multiple-projectile, 40-mm, XM576E1.

5) Cartridge, white-star cluster, 40-mm, XM585.

6) Cartridge, white-star parachute, 40-mm, XM583.

e. The launcher be so designed as to prevent the inadvertent chambering and firing of 40-mm high-velocity ammunition, such as the M384, which is intended for use in the M75 or other high-velocity 40-mm launchers.

f. The firing of the launcher, when attached to the point-fire weapons to which it is adapted, shall not produce a free-recoil energy greater than that produced by the M79 launcher when firing the same types of ammunition.

g. The temperature of the chamber area in the test launcher remain safely below the cook-off temperature of the components of the 40-mm M406 cartridge when a compliment of 400 rounds is fired within a 4-minute period from the M16A1 rifle to which the launcher is attached.

2.3.3 (U) Methods

2.3.3.1 Dry Firing Examination. An examination was made of each model launcher for any potential hazard to the rifleman in firing either the rifle or launcher element of the system from any standard firing position. Also, attempts were made to chamber and fire 40-mm high-velocity ammunition.

2.3.3.2 Firing Evaluation. Three launchers of each model were subjected to firings to learn whether any firing hazards exist. As a minimum the following firings were conducted:

a. Five rounds of proof ammunition were remotely fired from each launcher and then an additional five rounds were fired from the shoulder.

b. With the launchers loaded, cocked, and the safety in the FIRE position the rifles were fired 20 rounds semiautomatically, 40 rounds in short bursts, and 40 rounds automatically.

2.3.3.3 Inadvertent Fire Evaluation. Three launchers of each model were assembled to M16A1 rifles and dropped from a 5-foot height, butt-end first upon hard-packed earth. Prior to being dropped, the launchers were loaded with a dummy round, cocked and the safety placed in the FIRE position. The procedure was executed three times with each weapon.

2.3.3.4 Ammunition Compatibility. With the exception of the XM576E1 round, 20 rounds of each of the following listed types of ammunition were fired from a pump and pivot launcher. Due to limited supply of the XM576E1 cartridge only ten of these rounds were fired.these were:

a. Cartridge, 40-mm, XM387E3.

b. Cartridge, practice, 40-mm, M407.

c. Cartridge, HE, 40-mm, M406.

d. Cartridge, multiple-projectile, 40-mm, XM576E1.

e. Cartridge, white-star cluster, 40-mm, XM585.

f. Cartridge, white-star parachute, 40-mm, XM583.

Only the M407A1 practice and inert M406 cartridges were available for the DBCATA launcher; consequently, this launcher could only be tested with these type of cartridges.

2.3.3.5 Recoil Energy. The free-recoil energy of the rifle - launcher combinations was calculated and compared with that of the M79 launcher.

2.3.3.6 Cook-Off. Two thermocouples were attached to an inert M406 cartridge chambered in the launcher and one was attached to the rear of the launcher housing. The thermocouples on the cartridge were attached to the base of the projectile and across the face of the primer. The thermocouple on the launcher was attached in the vicinity of the rear mounting bracket. The rifle to which the launcher was attached was then fired 400 rounds within a 4-minute period and the temperatures recorded at the three points. The firing was conducted in a range environment of +70°F ± 5 with the rifle and launcher shielded to prevent rapid cooling from air circulation.

2.3.4 Results (U)

2.3.4.1 Initial Safety Examination (U). During the initial safety examination, inspection of the launchers and limited firing disclosed that all three launcher types had inherent features for which safety precautions must be observed. These were as follows:

a. Pump-launcher. The barrel-release latch could accidentally depressed by the gunner with rapid grasping of the handgrip on the launcher. This was a safety hazard in that live ammunition might be ejected to strike on hard surfaces.

The launcher can be fired with the barrel unlatched; however, to cause this, the barrel must be positioned and held less than 1/8 inch from the locked position. Normally when the barrel latch is depressed, the barrel automatically moves forward 1/2 to 3/4 inch. In such a position the cocking lever will stop the forward movement of the firing pin. Several rounds were fired with the barrel unlatched and no unsafe effects were observed.

The sight could be caused to change range setting with a heavy jolt on the buttstock of the rifle. This occurred during the evaluation for inadvertent firing when the weapon was dropped from a 5-foot height, butt end first, upon hard-packed earth. The stock of the rifle also cracked in the exercise.

b. Pivot-Launcher. The gunner could pinch his hand between the top of the ejector and the bottom edge of the handguard during the loading cycle.

c. DBCATA

1) The gunner can inadvertently grasp the assembled cartridge during firing rather than the handgrip on the launcher.

2) Contact with the sling swivel during recoil from firing the launcher can cause damage to the gunner's knuckles.

3) The sight on the DBCATA launcher was of the same design as that of the pump launcher and, similarly, was also subject to change of range setting with impact from the 5-foot drop.

4) The trigger group of the DBCATA launcher was of such design that the trigger could be partially pulled and fail to return to the forward position when released. In this partially pulled position, the launcher could not be put on safe and in order to cause the trigger to return to the forward position the gunner had to retract the charging handle. In some instances the gunner could push the trigger to the forward-position but in so doing he could cause the launcher to fire.

d. All launchers.

1) If the eye-relief distance is insufficient, it is possible for the shooter to be injured during recoil from firing the launcher.

(U) In an attempt to load and fire a high-velocity, 40-mm cartridge in the DBCATA launcher, it was found that no live cartridges could be assembled to the launcher; however, a dummy round which was being used for display could be assembled. Specifications for rim dimensions of the M169 case for the high-velocity ammunition are 1.714-0.005 inch minimum diameter before crimping and 1.725 inch maximum diameter after crimping. The drawings for the DBCATA launcher require the breech face to be 1.710 inch minimum to 1.714 inch maximum in diameter. Since the live rounds at APG could not be assembled, it was not determined whether the rounds could be fired if loaded in the DBCATA launcher.

(U) The calculated recoil energy for the pump and pivot launchers was 14 to 16 ft lbs, depending upon which round of ammunition was being fired and whether the launcher was assembled to the M16A1 rifle or the lighter XM177E2 submachine gun. The calculated recoil energy of the DBCATA launcher was 15 to 18 ft lbs, again depending upon the weapon to which the launcher was attached. The recoil of the DBCATA launcher was slightly greater than the other launchers owing to the higher velocity of the DBCATA ammunition. In comparison, the recoil energy of the M79 launcher was 22 to 24 ft lbs.

(U) In the opinion of the gunners at APG the recoil energy of the DBCATA launcher, as felt by the shooter, caused more discomfort than that when firing the M79 launcher. This was attributed mainly to the fact that the M79 launcher was equipped with a rubber recoil pad which covered more shoulder area of the gunner than did the butt plate on the M16A1 rifle. Consequently, the recoil of the DBCATA launcher was absorbed over a smaller area on the shoulder.

(C) The firing of 400 rounds from the M16A1 rifle in less than 2 minutes did not produce temperatures above the safe level with regard to cook-off of a chambered launcher round. The recorded temperatures are given in Table 2.3-I. In accordance with data reported in Reference 3 the 40-mm M406 HE round does not cook-off or deflagrate until temperatures of 310°F have been reached. Therefore, the temperatures induced in the attached launchers were well below the cook-off point of the M406 round.

Table 2.3-I (U). Temperature Data °F (U)

Launcher Type	Rear of Projectile	Rear of Primer	Rear of Launcher Housing[a]
Pump	168	184	200
Pivot	128	183	163
DBCATA	138	182	227

[a]The location of thermocouple is indicated by an arrow in Figure 2.3-1.

(U) The cook-off test disclosed that no problems existed with a chambered 40-mm round loaded in the launchers during the rapid firing of 400 rounds from the M16A1 rifle. However, this extended firing did produce a serious effect on the rifle. The heat generated in firing the 400 rounds caused permanent deformation of the gas tube and barrel to the extent that these were unserviceable. The barrel and gas tube on the M16A1 rifle with the pump launcher attached were the most severely damaged. It appears that this condition was attributable to the effects of the handguard design on the dissipation of heat, indicating the handguard for the pump launcher to be the most poorly designed for heat dissipation. Views of the rifles with deformed gas tubes are in Figures 2.3-1. The handguards employed on the weapons during the extended firing are shown in Figure 2.3-2.

2.3.4.2 (U) Additional Safety Consideration. After completion of the safety examination additional unsafe features were disclosed during test with all three launcher types. These were as follows:

a. Four instances of inadvertent firing of the pivot launchers occurred. In each instance the gunner pulled the trigger on the launcher and the hammer failed to fall, but with subsequent slight movement of the barrel, the launcher fired. The inadvertent firings were attributed to engagement between the barrel lock and the step-like sides of the barrel-lock slot in the ejector housing, which prevented proper positioning of the lock. With the barrel lock held in such a position, actuation of the trigger disengaged the sear and permitted the hammer to come to rest on the cocking shaft. With slight pivoting of the barrel, the lock moved into proper position thus releasing the cocking shaft and permitting the hammer to fall and fire the chambered round.

b. The primary sight on the pivot and DBCATA launchers changed range setting with recoil of the launcher.

c. Two instances of inadvertent firing of the M16A1 rifle occurred with firing of an attached pivot launcher during the hot test at +155°F. The weapons were being fired from a shoulder-held position. Inadvertent firing of the rifle was attributed to the recoil imparted to the rifle from firing of the launcher, which sometimes causes actuation of the trigger of the rifle. The actuation of the trigger usually does not fire the rifle since the bolt-carrier group also moves rearward with the firing of the launcher and the energy of the falling hammer is absorbed by the bolt-carrier group.

No inadvertent firing of the M16A1 rifle occurred throughout all tests with the firing of the pump or DBCATA launchers; however, the trigger on the rifle can be actuated with the recoil of either launcher. Trigger actuation occurred with the pivot and DBCATA launchers with all types of 40-mm ammunition when firing from shoulder-held positions, but with the pump launcher trigger-actuation occurred only when firing the XM576E1 shot shell round with the weapon in a solid rest.

It appears that trigger-actuation and inadvertent firing of the rifle with the firing of any of the attached launchers must be considered as potentially possible at any time, depending upon the peculiarities of individual rifle mechanisms and circumstances. This condition must be regarded as a safety hazard in the system.

d. As was stated in the foregoing paragraph, the bolt-carrier group in the M16A1 rifle moves rearward with the firing of the attached launcher. This rearward movement causes the bolt to unlock and partially extract the chambered rifle round. Subsequently, the bolt sometimes will fail to return to the locked position under the energy of the action spring. Since the rifle will not fire without remedial action when this occurs, the rifle must be considered rendered temporarily inoperative by the action of firing the launcher.

e. A short evaluation was conducted with the XM177E2 submachine gun to determine if the submachine gun would react to the recoil of the attached launcher as did the M16A1 rifle. The XM177E2 with each of the launchers attached was assembled in a solid rest and the launcher and submachine gun were each fired 20 rounds alternately. The M407A1 practice round was fired in the launchers. Additionally, 20 rounds were fired from the launcher with the submachine gun fully loaded and the selector set on automatic. It was found that, as with the M16A1 rifle, occassional actuation of the trigger on the submachine gun occurred with the firing of the pivot and DBCATA launchers and failures to fire due to opening of the bolt-carrier group occurred with the pump launcher. Also, the occurrence of trigger actuation on the submachine gun was experienced with the firing of the pivot launcher with the selector set for automatic fire. In all instances throughout the test this phenomenon was encountered with the M16A1 rifle only when the selector was set for semiautomatic fire. No unintentional firing of the submachine gun were experienced.

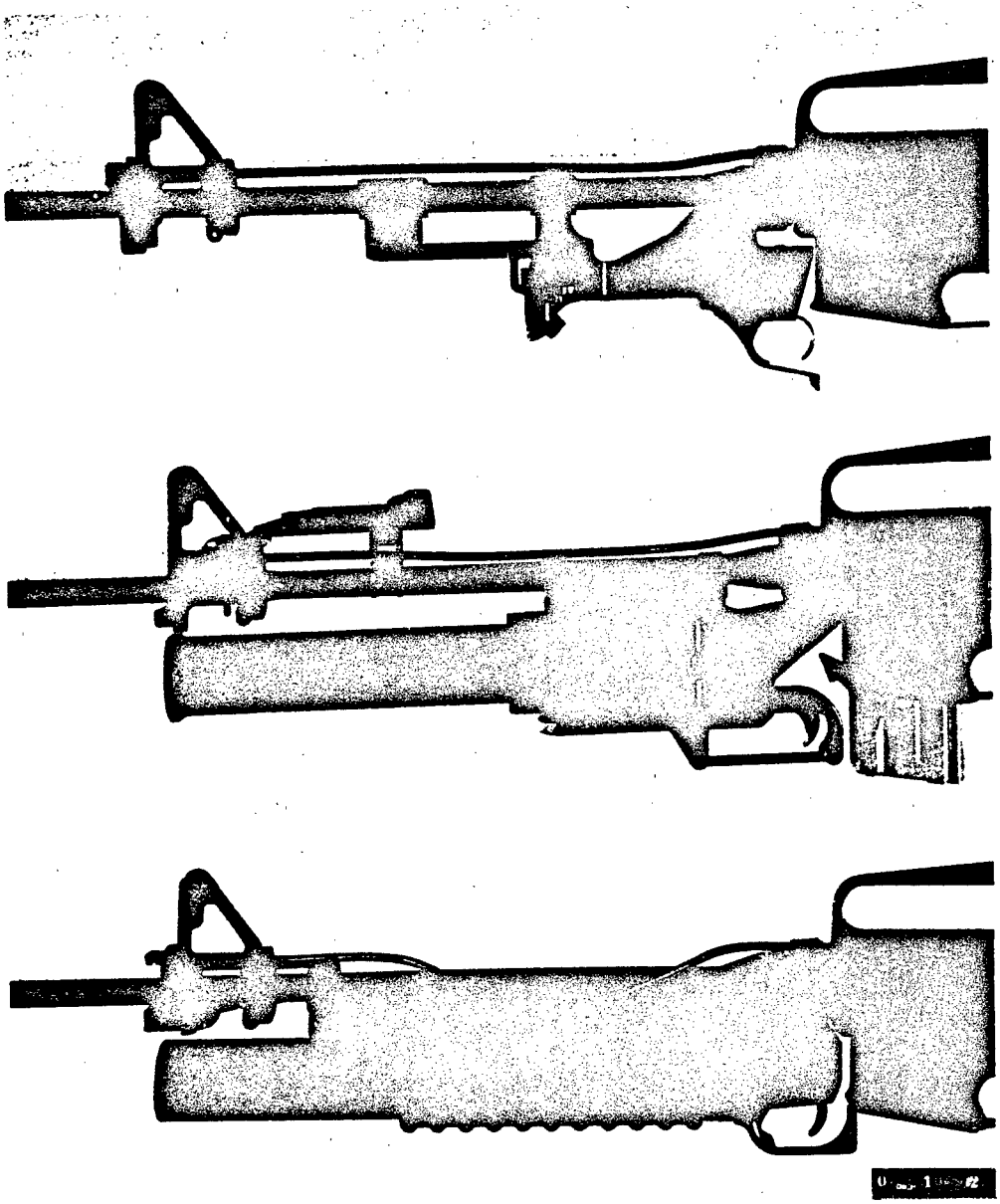


Figure 2.3-1 (U): M16A1 Rifle Gas Tubes after the Cook-Off Test. The Arrows Indicate Position where Thermocouples were Attached on Launcher Housings (U).

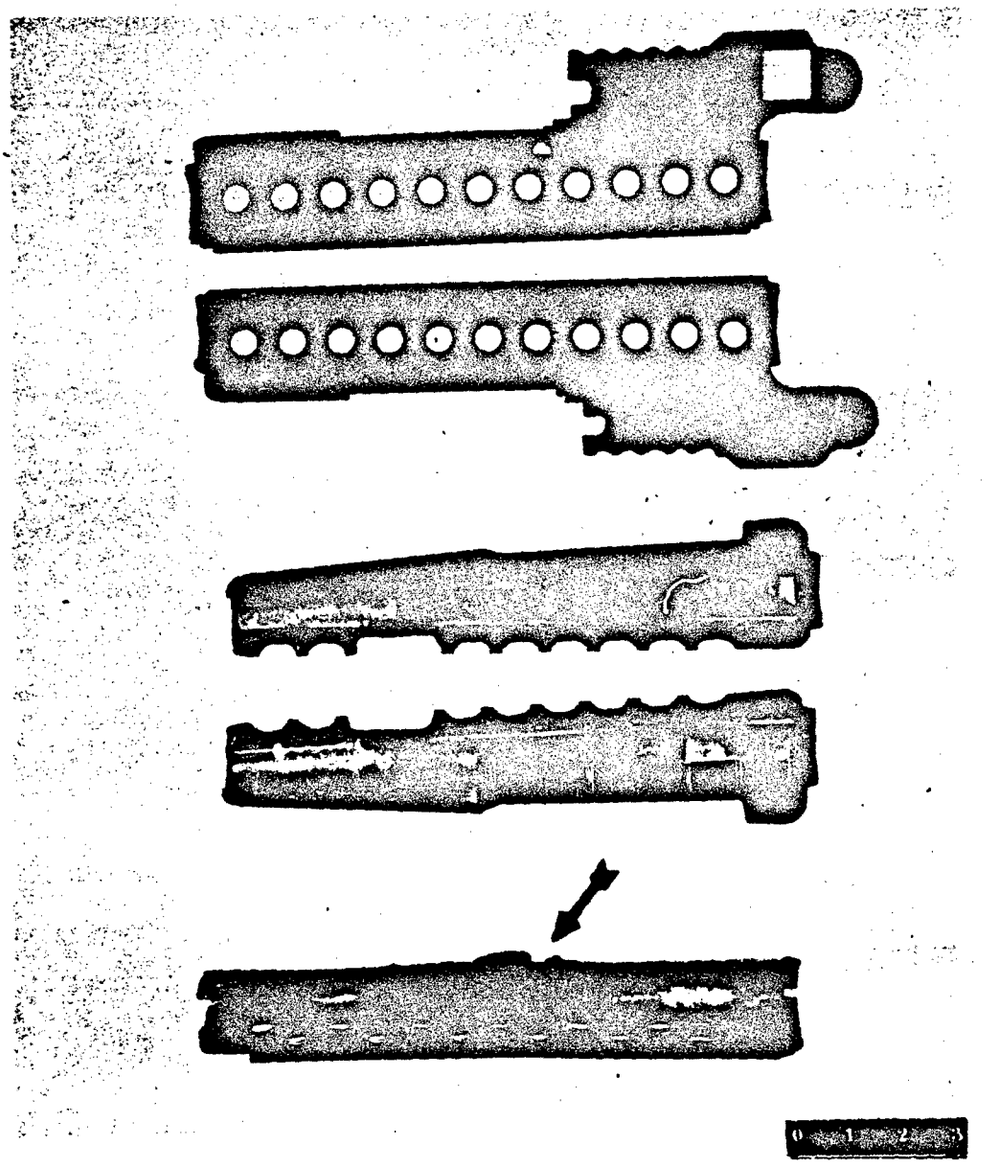


Figure 2.3-2 (U): Internal Views of Handguards Employed with the Three Launcher Types. TOP: DBCATA. MIDDLE: Pivot. BOTTOM: Pump. The Damage (Arrow) to the Handguard on the Pump Launcher Occurred when the Gas Tube on the Rifle Deformed and Contacted the Side of the Handguard (U).

2.3.5 (C) Analysis (U)

With the exception that it is highly improbable, but not impossible that a high-velocity round could be assembled to the DBCATA launcher, the requirements of the technical characteristics as outlined in the criteria, par. 2.3.2, were met with all three launchers.

2.4 VELOCITY, ACCURACY, AND DISPERSION TESTS (U)

2.4.1 (U) Objective

The objectives were:

a. To determine the velocity performance of the test launchers.

b. To determine any effects on the accuracy and dispersion of the M16A1 rifles from attachment and use of the launcher, and any effects on alignment and security of attachment of the launcher and sights from firing the rifle or launcher element of the weapon.

c. To determine the range accuracy and adequacy of sight graduations for the test launchers.

2.4.2 (C) Criteria (U)

It is required that:

a. The attachment of the launcher to the point-fire weapon and the subsequent firing thereof, shall not cause a shift in the center of impact of the point-fire weapon which exceeds two mils in deflection or two mils in elevation, when the weapon is fired either from the prone position with elbows supported, or from a foxhole position with the weapon supported.

b. The launcher shall, with aimed fire using the M406 cartridge, have such accuracy at all useable ranges up to 200 meters that one range probable error shall be less than 14 feet (4.3 meters) and one deflection probable error shall be less than three feet (0.9 meters).

2.4.3 (U) Method

2.4.3.1 Velocity Test. All pump and pivot launchers were fired 20 rounds each and the instrumental velocity at 20 feet from the muzzle was determined. Only three of the DBCATA launchers were fired for velocity measurements, as the launcher serves only as a launching platform for the disposable rifle casing; thus, each round fired has a new barrel. All ammunition was conditioned at $+70^{o}\pm2^{o}$F for a minimum of four hours prior to firing.

Firings were conducted from a bench rest. Three M79 grenade launchers were fired for control purposes.

2.4.3.2 Accuracy and Dispersion on a Vertical Target. Two launchers of each model and six M16A1 rifles were tested as follows from a benchrest position with the weapon supported on a sandbag:

a. Phase 1. The M16A1 rifles were zeroed at the 100-meters range on a vertical target by an expert rifleman and the sight setting for each was recorded. Three 10-round groups were then fired with each rifle.

b. Phase 2. Test launchers were attached and three 10-round groups were fired from each rifle using the same sight setting established in phase 1.

c. Phase 3. At 50-meters range the launchers were zeroed on a vertical target and three 10-round groups were fired with each launcher. If a battle sight was provided, three additional 10-round groups were fired using the battle sight.

d. Phase 4. Three additional 10-round groups were fired with the rifles using the sight setting established in phase 1.

e. Phase 5. Three 10-round groups were fired with each launcher using the sight setting established in Phase 3.

2.4.3.3 Launcher Accuracy. Two expert rifleman each fired a 20-round group for ground impact at ranges of 100, 200, and 350 meters with each of two launchers of each model attached to M16A1 rifles. Before firing for record, the launcher sights were adjusted by one rifleman to impact the grenades at the 200-meter range. Thereafter, the only sight adjustment made was to set the sight scale at the appropriate graduation for each range. The test was repeated with one launcher of each model attached to an XM177E2 submachine gun. One M79 launcher was fired for control purposes.

The foregoing accuracy procedures were repeated with the pivot launchers using the battle sight and firing 10-round groups at each designated range on the sight scale.

All firings were conducted from a benchrest with wind conditions of ten mph and below for ranges up to and including 200 meters and five mph and below for ranges greater than 200 meters.

2.4.4 (U) Results

2.4.4.1 Velocity Test. The instrumental velocity data for the launchers are given in Table 2.4-I.

Table 2.4-I (U). Velocity Data (U)

The velocity data are in feet per second and are an average of 20-round groups.

Launcher No.	Avg IV 20 ft from Muzzle	Velocities		Variations		
		Max	Min	Mean	Extreme	Std Dev
Cartridge: 40-mm, M407A1 with dummy fuze, lot MA-SP-516.						
Launcher: Pump.						
08	246.5	252.7	237.9	2.6	14.8	3.5
09	245.2	259.9	240.3	1.4	9.6	2.0
10	238.5	244.0	234.0	2.6	10.0	3.0
11	241.5	248.4	228.6	2.4	19.8	3.8
12	247.5	251.2	241.8	2.1	9.4	2.6
13	246.3	252.0	242.1	1.8	9.9	2.3
14	245.6	249.7	240.9	2.0	8.8	2.5
15	245.4	248.4	242.6	1.7	5.8	1.9
16	244.0	246.3	241.2	1.0	5.1	1.3
17	238.6	242.4	232.7	1.9	9.7	2.5
18	243.6	247.8	240.7	1.5	7.1	1.9
20	237.7	241.8	233.9	2.1	7.9	2.6
Avg	243.4			1.9	9.8	2.5
Launcher: Pivot.						
02	240.4	243.9	236.9	2.4	7.0	2.6
03	234.5	237.2	230.1	1.7	7.1	2.1
04	234.7	238.4	229.3	1.8	9.1	2.3
05	233.4	237.0	229.3	1.6	7.7	2.0
06	238.1	242.7	233.2	1.8	9.5	2.3
07	234.7	239.8	228.0	2.4	11.8	3.0

Table 2.4-I (Cont'd)

Launcher No.	Avg IV 20 ft from Muzzle	Velocities		Variations		
		Max	Min	Mean	Extreme	Std Dev
08	235.2	239.7	229.9	2.2	9.8	2.7
09	237.1	243.4	229.7	3.1	13.7	3.7
10	234.8	241.5	230.4	2.1	11.1	2.8
11	229.4	236.8	221.6	2.8	15.2	3.6
12	232.6	239.0	223.3	2.4	15.8	3.4
13	232.7	238.7	228.0	2.5	10.7	3.1
Avg	234.8			2.2	10.7	2.8
Launcher: M79.						
30887	237.0	240.7	231.2	2.1	9.5	2.7
30898	236.0	239.7	232.0	1.6	7.7	2.0
30965	234.2	238.8	231.6	1.4	7.2	1.8
Avg	235.7			1.7	8.1	2.2

Note: The following data were obtained with launchers and cartridge lots used in the range-accuracy phase.

Cartridge: 40-mm, DBCATA, M407A1 with M551 fuze, lot 51303-1017.
Launcher: DB.

11	253.7	257.7	251.4	1.9	11.5	2.7
12	252.1	256.4	248.8	1.7	8.3	2.1
13	252.8	257.4	245.9	1.9	8.5	2.4
Avg	252.9			1.8	9.4	2.4

Cartridge: 40-mm, M407A1, practice, lot MA-79-12.
Launcher: Pump.

12	242.4	245.4	238.4	1.8	7.0	2.1
13	240.8	249.3	233.5	2.7	15.8	3.5
Avg	241.6			2.2	11.4	2.8
Launcher: Pivot.						
06	231.6	236.8	228.5	1.7	8.3	2.1
07	232.4	236.0	227.5	1.9	8.5	2.4
Avg	232.0			1.8	8.4	2.2
Launcher: M79.						
30887	234.2	240.8	220.9	2.0	19.9	3.0

As reported in Jefferson Proving Ground Acceptance Firing Record 68-1643, the corrected average velocity of lot MA-SP-516 was 253.6 fps with a standard deviation of 2.3 fps, and that for lot MA-79-12, as reported in Acceptance Firing Record 67-7905, was 251.7 fps average and 2.5 fps standard deviation. Lot MA-SP-516 exceeded the 252.0 fps maximum permissable average velocity for this round, but was accepted on waiver.

2.4.4.2 Accuracy and Dispersion on a Vertical Target. Data from the benchrest firings (phases 1 through 5) to determine the effects on accuracy of the M16A1 rifle from attachment and use of the launcher and effects on launcher accuracy from use of the rifle, are given in Tables 2.4-II and -III. The change in center of impact resulting with the rifle when a launcher was attached is given in Table 2.4-IV.

Table 2.4-II (U). Rifle Accuracy Data (U)

All target measurements are in inches and are an average of three 10-round groups at 100-meters range.

Rifle No.	Attached Launcher	Group Center from Aiming Point		Mean Radius	Deviations				Extremes		
					Hor		Vert				
		Hor	Vert		Mean	Std	Mean	Std	Hor Disp	Vert Disp	Spread
Condition:	**Without launcher attached (Phase 1).**										
802660	Pump 12	+0.8	+1.6	1.4	0.7	1.0	1.0	1.3	3.5	4.1	4.5
814369	Pump 13	-0.1	+3.3	0.9	0.6	0.8	0.5	0.6	2.7	1.7	3.1
810980	Pivot 06	+2.0	+3.3	1.3	0.7	0.9	1.0	1.2	2.8	3.3	3.8
813592	Pivot 07	+1.3	+3.5	1.0	0.7	0.8	0.7	0.8	2.5	2.5	3.0
812453	DBCATA 11	+1.0	+4.3	0.8	0.5	0.6	0.6	0.7	1.9	1.9	2.5
803828	DBCATA 12	+0.2	+4.3	1.6	1.1	1.4	1.0	1.2	3.8	3.4	4.9
Condition:	**With launcher attached (Phase 2).**										
802660	Pump 12	+1.6	+0.5	1.4	0.9	1.2	0.9	1.1	4.3	3.1	4.7
814369	Pump 13	-0.3	+3.2	1.1	0.7	0.8	0.7	0.9	2.5	2.7	3.7
810980	Pivot 06	+3.2	+9.7	1.0	0.6	0.8	0.7	0.9	2.6	2.7	3.2
813592	Pivot 07	-2.4	+7.4	1.0	0.4	0.6	0.8	1.1	1.8	3.5	3.7
812453	DBCATA 11	+1.7	+5.8	1.3	0.6	0.7	1.0	1.3	2.2	4.1	4.7
803828	DBCATA 12	-2.3	+5.5	1.5	1.0	1.3	0.9	1.3	4.2	4.6	5.5
Condition:	**After firing the launcher (Phase 4).**										
802660	Pump 12	+1.1	+1.5	1.5	1.0	1.3	1.0	1.3	4.1	4.3	5.6
814369	Pump 13	-0.5	+2.1	0.9	0.5	0.8	0.5	0.8	2.8	2.6	3.1
810980	Pivot 06	+3.8	+9.6	1.1	0.8	1.1	0.6	0.8	3.7	2.4	4.0
813592	Pivot 07	-1.4	+7.8	0.8	0.5	0.6	0.5	0.7	2.0	2.3	2.5
812453	DBCATA 11	+1.3	+2.6	1.2	0.5	0.7	1.0	1.3	2.0	4.2	4.3
803828	DBCATA 12	-1.1	+3.2	1.3	0.9	1.2	0.8	1.0	3.6	3.3	4.5

Table 2.4-III (U). Launcher Bench Rest Accuracy Data (U)

All target measurements are in inches and are an average of three 10-round groups at 50 meters range.

Launcher No.	Group Center from Aiming Point Hor	Group Center from Aiming Point Vert	Mean Radius	Deviations Hor Mean	Deviations Hor Std	Deviations Vert Mean	Deviations Vert Std	Extremes Hor Disp	Extremes Vert Disp	Extremes Spread
Condition: After being zeroed, but befcre firing the rifle (phase 3).										
Pump 12	- 3.8	+ 6.2	4.5	1.9	2.2	3.9	4.9	6.3	14.4	15.1
Pump 13	+ 8.9	- 1.3	3.9	1.7	2.3	3.0	4.3	7.3	13.9	14.4
Pivot 06	+ 1.1	+ 8.3	3.5	1.6	2.1	2.8	3.9	6.3	13.3	14.2
Pivot 07	+ 0.3	+ 6.3	3.2	1.7	2.4	2.2	3.1	7.8	10.8	11.9
DBCATA 11	+ 3.9	- 1.0	4.9	3.6	4.5	2.9	3.5	12.8	10.4	15.4
DBCATA 12	- 1.4	+ 1.8	4.6	2.7	3.5	3.1	3.8	11.5	12.4	13.5
Condition: After firing the rifle (phase 5).										
Pump 12	- 6.6	+ 5.0	3.5	1.6	2.0	2.9	3.6	6.1	11.1	11.6
Pump 13	+ 8.7	- 3.2	4.0	1.4	1.7	3.5	4.6	5.3	15.4	15.5
Pivot 06	-13.5	+ 7.1	3.5	1.9	2.4	2.7	3.3	7.6	9.8	10.5
Pivot 07	- 2.3	+ 4.1	2.7	1.5	1.8	1.9	2.5	5.4	8.2	9.2
DBCATA 11	+ 3.8	+ 4.1	5.5	3.6	4.4	3.4	4.6	13.5	14.7	17.4
DBCATA 12	[a]-16.9	+ 6.1	5.7	3.9	5.0	3.3	4.2	14.8	13.5	17.8
Condition: Using the battle sight.										
Pivot 06	+ 6.0	+15.4	4.6	2.4	3.2	3.3	4.2	9.7	13.0	13.9
Pivot 07	+ 0.8	+ 1.9	4.5	1.8	2.3	3.7	4.6	7.0	14.3	14.5

[a]After-firing inspection disclosed that one-half of the insulator in the front barrel bracket had broken and fallen out of the bracket and the other half had moved out of position. The shift in group location relative to that recorded in phase 3 was attributed to the faulty barrel bracket insulator.

Table 2.4-IV (U). Change in Group Center of Impact Which Occurred with the Attachment of a Launcher to the M16A1 Rifle (U)

Rifle No.	Launcher Attached	Shift in Group Location[a] Hor	Vert
Range: 100 meters.			
802660	Pump 12	+0.8	-0.9
814369	Pump 13	-0.2	-0.1
810980	Pivot 06	+1.2	+6.4
813592	Pivot 07	-3.7	+3.9
812453	DBCATA 11	+0.7	+1.5
803828	DBCATA 12	-2.5	+1.2

[a]The distance and direction of shift is relative to the group location without a launcher attached.

The attachment of the pivot launcher was the only launcher of the three types that caused a shift in center-of-impact location of the rifle that was larger than those resulting in normal group-to-group shifts of the rifle. The sights on the rifles could be readjusted to compensate for the shift with latitude remaining for further adjustment. The recorded sight settings for the M16A1 rifles before attachment of the launchers are given in Table 2.4-V.

Table 2.4-V (U). Recorded Rifle-Sight Settings before Attachment of a Launcher (U)

Rifle No.	Launcher Attached	No. of Clicks[a] Windage[b]	Elevation[c]
802660	Pump 12	21	30
814369	Pump 13	21	32
810980	Pivot 06	22	27
813592	Pivot 07	21	29
812453	DBCATA 11	8	28
803828	DBCATA 12	21	31

[a]One click in windage or elevation moves the bullet impact at 100 meters approximately 1.1 inch.
[b]The figure represents the number of clicks of windage from the extreme left sight position. The rear sight has a range of 32 clicks of windage.
[c]The figure represents the number of clicks of elevation from the lowest sight position. The front sight has a range of 40 clicks of elevation.

The changes in the center of impact of launcher shot groups (Table 2.4-III) occurring with the firing of the rifle were not greater than variations among individual groups. Only one DBCATA launcher experienced a large shift and that was attributed to a faulty barrel bracket insulator.

The cause for the increase in dispersion of the pivot launchers with use of the battle sight relative to that when using the primary sight was unknown. In the opinion of the gunners the primary sight with a peep and front post could be more accurately aligned than could the open, ladder-type battle sight. The accuracy data on the horizontal target, as reported in par. 2.4.4.3, does not necessarily support this, because, in most instances, the group size when using the battle sight on the pivot launcher was smaller than when using the primary sight. However, with use, the leaf spring on the primary sight which holds the front post developed cracks; consequently, it lost tension and failed to return to position with each round fired. Hence, an increase in dispersion would result.

2.4.4.3 Launcher Accuracy. The test results of the range accuracy firings with the launchers conducted to test the accuracy of the sight graduations on the launcher sights and to determine the dispersion of the launchers at the various ranges when attached to the M16A1 rifle are given in Table 2.4-VI. Accuracy and dispersion data with one M79 launcher, using the same lot of ammunition, are also given in this table. The accuracy and dispersion data for the test launchers when attached to the XM177E2 submachine gun are given in Table 2.4-VII.

Only the pivot launcher was provided with a battle sight. The accuracy and dispersion data of the pivot launcher when using the battle sight are given in Table 2.4-VIII.

Table 2.4-VI (U). Launcher Accuracy Data when Attached to the M16A1 Rifle (U)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Ammunition: Cartridge, 40-mm, M407A1, practice, lot MA-79-12 (for pump, pivot and M79) and cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1017 (for DBCATA).										
Range: 100 meters.										
Launcher: Pump.										
12	93.0	-0.5	2.2	2.2	0.2	3.1	0.3	14.2	1.3	14.2
13	98.0	-0.2	2.0	1.9	0.2	2.7	0.4	11.6	1.7	11.6
Avg	95.5	-0.4	2.1	2.0	0.2	2.9	0.4	12.9	1.5	12.9
Launcher: Pivot.										
06	107.9	-0.3	2.6	2.6	0.2	3.7	0.2	16.0	0.9	16.1
07	109.3	-0.9	2.7	2.6	0.4	3.3	0.5	13.0	1.9	13.0
Avg	108.6	-0.6	2.6	2.6	0.3	3.5	0.4	14.5	1.4	14.6
Launcher: DBCATA.										
11	105.5	-1.0	2.2	2.2	0.2	2.8	0.2	10.9	0.8	10.9
12	102.6	-0.6	2.3	2.3	0.2	3.3	0.2	14.3	0.9	14.3
Avg	104.0	-0.8	2.2	2.2	0.2	3.0	0.2	12.6	0.8	12.6
Launcher: M79.										
1	111.8	-0.9	3.7	3.7	0.7	5.2	0.2	22.4	0.2	22.4
Range: 200 meters.										
Launcher: Pump.										
12	202.6	-0.3	3.6	3.5	0.4	4.3	0.5	15.5	1.7	15.5
13	205.2	-0.1	3.6	3.6	0.4	4.5	0.5	17.9	1.8	17.9
Avg	203.9	-0.2	3.6	3.6	0.4	4.4	0.5	16.7	1.8	16.7

[a]The data are the average of firings by two riflemen each firing a 20-round group with each launcher.

Table 2.4-VI (Cont'd)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Launcher: Pivot.										
06	193.9	+0.5	3.6	3.5	0.5	5.0	0.6	22.6	2.2	22.7
07	193.8	+1.3	3.8	3.8	0.3	4.7	0.4	17.8	1.7	17.8
Avg	193.8	+0.9	3.7	3.6	0.4	4.8	0.5	20.2	2.0	20.2
Launcher: DBCATA.										
11	195.7	-1.8	5.6	5.4	0.7	7.2	1.2	27.3	5.3	27.3
12	205.0	-1.6	4.2	3.9	0.9	4.8	1.5	17.5	5.7	17.5
Avg	200.4	-1.7	4.9	4.6	0.8	6.0	1.4	22.4	5.5	22.4
Launcher: M79.										
1	201.6	-1.0	3.2	3.1	0.4	4.1	0.5	17.0	1.6	17.0
Range: 350 meters.										
Launcher: Pump.										
12	342.7	+4.4	6.8	6.4	1.3	8.2	1.7	30.4	6.3	30.5
13	349.8	+2.9	7.6	7.0	2.1	8.9	2.7	32.5	9.4	33.1
Avg	346.2	+3.6	7.2	6.7	1.7	8.6	2.2	31.4	7.8	31.8
Launcher: Pivot.										
06	333.9	+5.4	6.7	6.3	1.4	8.0	1.7	29.2	6.3	29.4
07	337.3	+5.9	7.8	7.3	1.7	9.1	2.3	34.0	8.9	34.1
Avg	335.6	+5.6	7.2	6.8	1.6	8.6	2.0	31.6	7.6	31.8
Launcher: DBCATA.										
11	344.1	-1.3	10.2	9.8	1.8	12.0	2.2	40.1	8.1	40.1
12	354.7	-2.0	9.2	8.8	1.6	11.2	2.0	41.3	7.7	41.5
Avg	349.4	-1.6	9.7	9.3	1.7	11.6	2.1	40.7	7.9	40.8

[a]The data are the average of firings by two riflemen each firing a 20-round group with each launcher.

Table 2.4-VI (Cont'd)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Launcher: M79.										
1	237.9	0.7	5.4	5.0	1.5	6.1	1.8	22.9	6.5	23.6

[a]The data are the average of firings by two riflemen each firing a 20-round group with each launcher.

Table 2.4-VII (U). Launcher Accuracy Data when Attached to the XM177E2 Submachine Gun (U)

Launcher	Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Ammunition: Cartridge, 40-mm, M407A1, practice, lot MA-79-12 (for pump and pivot) and cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1017.											
Range: 100 meters.											
Pump	12	100.3	-0.2	2.6	2.6	0.2	3.3	0.2	13.2	1.0	13.2
Pivot	06	117.7	-1.9	3.6	3.5	0.2	4.3	0.3	16.0	1.0	16.0
DBCATA	11	108.5	-0.1	1.9	1.9	0.2	2.4	0.2	8.8	0.7	8.8
Range: 200 meters.											
Pump	12	201.1	+0.2	3.7	3.6	0.3	4.6	0.4	17.5	1.6	17.5
Pivot	06	197.8	+0.8	4.9	4.8	0.5	6.4	0.6	26.6	2.3	26.6
DBCATA	11	211.7	-0.2	4.2	4.1	3.1	5.0	0.5	17.6	0.7	17.6
Range: 350 meters.											
Pump	12	229.8	+5.5	6.8	6.1	1.9	7.8	2.4	31.5	9.8	31.7
Pivot	06	230.1	+1.7	6.6	6.2	1.7	7.6	2.2	28.6	8.3	28.8
DBCATA	11	244.6	+1.5	9.1	8.7	1.6	12.1	2.1	47.5	7.7	47.8

[a]The data are the average of firings by two riflemen each firing a 20-round group with one launcher attached to an XM177E2 submachine gun.

Table 2.4-VIII (U). Pivot Launcher Accuracy Data using the Battle Sight (U)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Ammunition: Cartridge, 40-mm, M407A1, practice, lot MA-79-12. Launcher attached to: M16A1 rifle. Range: 50 meters.										
06	62.3	-0.1	1.8	1.8	0.1	2.1	0.1	6.2	0.3	6.2
07	66.5	-0.3	1.1	1.1	0.1	1.4	0.1	4.2	0.4	4.2
Avg	64.4	-0.2	1.4	1.4	0.1	1.8	0.1	5.2	0.4	5.2
Range: 100 meters.										
06	103.8	-0.2	2.6	2.5	0.1	3.1	0.2	9.7	0.6	9.8
07	106.5	-0.2	3.2	3.2	0.1	4.4	0.2	13.8	0.6	13.8
Avg	105.2	-0.2	2.9	2.8	0.1	3.8	0.2	11.8	0.6	11.8
Range: 150 meters.										
06	157.2	-0.2	3.7	3.7	0.3	4.6	0.4	15.2	1.3	15.3
07	158.1	-0.7	2.9	2.8	0.3	3.5	0.5	10.2	1.7	10.2
Avg	157.6	-0.4	3.3	3.2	0.3	4.0	0.4	12.7	1.5	12.7
Range: 200 meters.										
06	197.1	+0.6	3.5	3.4	0.5	4.4	0.6	13.2	1.9	13.3
07	198.1	0.0	3.0	2.9	0.3	3.6	0.5	11.4	1.5	11.5
Avg	197.6	+0.3	3.2	3.2	0.4	4.0	0.6	12.3	1.7	12.4
Range: 250 meters.										
06	234.3	+0.7	4.6	4.5	0.5	5.7	0.6	17.5	1.9	17.5
07	237.6	-1.7	4.7	4.7	0.5	5.5	0.5	15.9	1.6	15.9
Avg	236.0	-0.5	4.6	4.6	0.5	5.6	0.6	16.7	1.8	16.7

[a]The data are the average of firings by two riflemen each firing a 10-round group with each launcher.

Table 2.4-VIII (Cont'd)

Launcher No.	Target Data, meters[a] Center of Impact Range	Defl	MR	Mean Dev Range	Defl	Std Dev Range	Defl	Extreme Disp Range	Defl	Extreme Spread
Launcher attached to: XM177E2 submachine gun.										
Range: 50 meters.										
06	64.3	+0.1	2.8	2.8	0.1	3.4	0.2	9.5	0.8	9.5
Range: 100 meters.										
06	106.5	+0.4	1.8	1.8	0.2	2.5	0.2	8.8	0.7	8.8
Range: 150 meters.										
06	149.1	+0.9	2.8	2.8	0.2	3.7	0.3	12.2	1.1	12.8
Range: 200 meters.										
06	193.1	+0.4	2.8	2.7	0.4	3.6	0.5	11.1	1.5	11.1
Range: 250 meters.										
06	240.5	[illegible].6	4.1	4.0	0.4	5.2	0.6	16.7	2.0	16.9

[a]The data are the average of firings by two riflemen each firing a 10-round group with each launcher.

The round-to-round dispersion of the groups at all ranges with the pump and pivot launchers was comparable. However, the sight on the pivot launcher was not correctly graduated for the velocity level produced by the launchers with the test lot of ammunition. The firings with the M79 launcher demonstrated that the M79 sights also did not fit the test lot of ammunition, in approximately the same manner and to the same degree as the pivot launcher sights. It should be noted that the M79 and pivot launchers were comparable with regard to velocity level. The sights on the pump launcher were reasonably well matched to the test lot of ammunition; however, the pump launcher fired the test lot at approximately ten feet per second higher velocity than did the pivot or M79 launchers. The battle sight provided for use with the pivot launcher also was not correctly graduated.

The graduations on the sight for the DBCATA launcher were accurate at all ranges; however, the round-to-round dispersion when attached to the M16A1 rifle was slightly greater than that of the pump and pivot launchers.

2.4.5 (U) Analysis

All three test launchers met the requirements of the technical characteristics as outlined in the criteria, par. 2.4.2.

2.5 LOW-TEMPERATURE TEST (-65°F) (U)

2.5.1 (U) Objective

The objective was to determine the functioning performance of the test launchers under conditions of low temperature.

2.5.2 (C) Criteria (U)

It is required that the launcher be capable of being maintained and operated under -25°F temperature conditions and desired that it be capable of the same under -65°F conditions.

2.5.3 (U) Method

Three launchers of each model were cleaned, lubricated and attached to M16A1 rifles. The weapons and ammunition were then subjected to a temperature of -65°F for a minimum of 24 hours prior to firing. The firing procedure consisted of attempting to fire 20 rounds from each of the launchers, and 40 rounds semiautomatically and 60 rounds in 3-to 5-round bursts from each of the rifles. This procedure was repeated four times with a reconditioning period at temperature for a minimum of 1 hour between each series. Two M79 grenade launchers were fired in a similar manner for control purposes.

2.5.4 (U) Results

The malfunction data recorded in the low-temperature test are given in Table 2.5-I.

Table 2.5-I (U). Cold Test Function Data (U)

Launcher No.	Function[a]	Remarks
Ammunition: Cartridge, 40-mm M407A1 with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 100. Launcher: Pump.		
8	42-FX 6-FFRL	After-firing inspection revealed both bracket insulators to be badly chipped.
10	1-FX 2-FFRL 2-PS	After-firing inspection revealed the bracket insulators to be broken. Both were replaced with insulators of darker-colored material.

See footnote on following page.

Table 2.3-I (Cont'd)

Launcher No.	Function[a]	Remarks
11	11-FX 4-FFRL 2-PS	
Launcher:	Pivot.	
9	8-FJ 5-FFRL 2-FER 1-PS	
10	15-FFRL 2-PS	
11	5-FJ 8-FFRL 2-FER	
Launcher:	M79.	
2	4-FFRL 1-FX	
3	9-FFRL 1-FX	
Ammunition:	Cartridge, 40-mm, DBCATA, M406 with dummy fuze, inert, lot No. 51303-1018 (60 rounds total), and DBCATA, M407A1, practice, lot No. 51303-1018 (240 rounds).	
8	19-FS 7-FFRL	
9	26-FS 3-FFRL	The mounting screw on the sight came loose during firing. After-firing inspection revealed the front and rear bracket insulators were broken. Both were replaced with insulators of darker-colored material.
10	26-FFS 7-FFRL	The mounting screw on the sight came loose during firing.

[a]Disassembly and inspection of the rounds identified in the above table as failures to fire (FFRL) in the pump, pivot, and M79 launchers disclosed that 44 of the total of 53 had actually fired, with the propellant burning within the case but failing to generate sufficient pressures to force the projectile out of the case. The remaining nine rounds were actual failures to fire and of these four were with the pump launchers and five were with the pivot launchers. It could not be determined whether the nine failures to fire were attributable to the weapons or resulted from defective primers.

Of the failures to extract (FX) encountered with the pump launchers, launcher No. 8 had 42 and launcher No. 10 had one. Inspection of the two launchers revealed a definite difference in the angle at which the hook on the extractor engaged the rim of the case. The angle of the hook on the extractor in the launcher which had one failure to extract was cut to slope towards the rim (negative angle), whereas the angle on the extractor in the launcher which had 42 failures to extract sloped away from the rim (positive angle). The failure-to-extract problem was attributed to the positive angle of cut on the extractor hook. At this point in testing, with the concurrence of AMCPM-RS, all extractors in the pump launchers at APG were modified to have a negative 3-degree angle. The low temperature test was not repeated to ascertain the competence of the modification under cold conditions on the basis that the launcher with a negative angle on the extractor hook had demonstrated satisfactory extraction performance in the low-temperature test.

With the concurrence of AMCPM-RS, the Code AA representative replaced the 0.016-inch-diameter wire primary sear spring with a spring made of 0.022-inch-diameter wire. This modification was made in an attempt to correct the failure to sear problem and also to correct the unsafe feature of the trigger remaining in a partially pulled position as described in paragraph 2.3.4c(4) of the safety examination. The heavier spring did not correct the unsafe condition and the results of subsequent subtests showed that it did not correct the failure to sear malfunction.

2.5.5 (U) Analysis

All of the test launchers were capable of being maintained and operated at the -65°F temperature. On the basis that the modification made to the extractor on the pump launcher corrected the failure-to-extract malfunction, the performance of the pump launcher would be superior to that of the pivot and DBCATA launchers.

2.6 HIGH-TEMPERATURE TEST (+155°F) (U)

2.6.1 (U) Objective

The objective was to determine the functioning performance of the test launchers under conditions of high temperature.

2.6.2 (C) Criteria (U)

It is required that the launcher be capable of being maintained and operated under +125°F temperature conditions and desired that it be capable of the same under +155°F conditions.

2.6.3 (U) Method

Three launchers of each model were cleaned, lubricated, and attached to M16A1 rifles. The weapons and ammunition were then subjected to a temperature of +155°F for 12 hours prior to firing. The test procedure consisted of firing 20 rounds from each of the launchers and 40 rounds semiautomatically and 60 rounds in 3- to 5-round bursts from each of the rifles. This procedure was repeated four times with a reconditioning period at temperature for a minimum of one hour between each series. Two M79 grenade launchers were fired in a similar manner for control purposes.

2.6.4 (U) Results

The malfunction data recorded during the hot test are given in Table 2.6-I.

Table 2.6-I (U). Hot Test Function Data (U)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1, with dummy fuze, lot MA-SP-172. No. of Rounds Fired per Launcher: 100.		
Launcher: Pump.		
8	Satis	The glue on the handguard broke loose, which allowed the handguard to slide along the barrel of the launcher.
10	Satis	Twenty slightly riveted primers occurred.
11	Satis	
Launcher: Pivot.		
09	5-FJ 3-FRRS	The sight shifted range setting during firing of the launcher.
10	2-FJ 4-FFRR	Same remark as with pivot-launcher No. 9.
11	2-FJ 1-FER 7-FFRR 4-FRRS 2-IAVF	Same remark as with pivot-launchers No. 9 and 10. The two occurrences of inadvertent fire occurred with the rifle during the firing of the last 20-round cycle from the launcher.
Launcher: M79.		
2	Satis	
3	1-FX	

Table 2.6-I (Cont'd)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice lot 51303-1018. Launcher: DBCATA.		
8	12-FS 3-FFRR 7-FRRS	The sight shifted in range-setting during firing of the launcher and the sight-mount screw came loose during firing of the rifle.
9	21-FS 8-FFRR 6-FRRS	Same remark as with DBCATA No. 8.
10	9-FS 7-FFRR 2-FRRS	Same remark as with DBCATA Nos. 8 and 9.

The two instances of inadvertent firing of the M16A1 rifle were attributed to recoil imparted to the rifle from firing of the attached launcher. The recoil caused the trigger on the rifle to actuate; subsequently, the hammer failed to remain seared and fell. Usually, the fall of the hammer under these circumstances does not fire the rifle because the bolt-carrier group is recoiled rearward with the firing of the launcher and the energy of the hammer is absorbed on the carrier.

Further discussion of the failure of the rifle to remain seared with the firing of the launcher is contained in paragraph 2.3.4 of the safety examination.

The occurrence of riveted primers with one of the pump launchers was an indication of excessive headspace which, on the pump launcher, is controlled by the extractor. The riveting was only slight and did not occur with all rounds. Measurement of the distance between the tip of the extractor hook and the breech face disclosed 0.093 inch on the launcher which was experiencing riveted primers and 0.084 and 0.085 inch on the other two launchers. A similar measurement on the pump launchers in the reliability test disclosed that two of the three launchers had a headspace of 0.90 inch and the third a headspace of 0.080 inch. No problems of riveted primers or indications of such occurred during the reliability test. Based on the foregoing the tolerances for headspace in the pump launcher should be 0.085 ± 0.005 inch.

After-test inspection disclosed the barrel bracket insulators on all pump launchers, including those on launcher No. 11 which were of new material, to be chipped but still serviceable. Those in DBCATA launcher Nos. 8 and 10 were also broken and were replaced with

insulators of the new material. Also the barrel bracket screws on all of the pump launchers were bent in the area where the head joins the body of the screw. The bent screws were replaced with screws of longer length.

Inspection also disclosed that the leaf spring which held the bracket for the peep sight in position on the sight for DBCATA launcher No. 8 had taken a set. This allowed the peep sight to move out of position. A new spring was installed by the Code AA representative.

2.6.5 (U) Analysis

All three launcher types were capable of being maintained and operated under +155°F temperature conditions; however, the function performance of the pump launcher was superior to that of the pivot and DBCATA launchers.

2.7 STATIC DUST TEST (U)

2.7.1 (U) Objective

The objective was to determine the functioning performance of the test launchers after being subjected to adverse conditions of dust.

2.7.2 (C) Criteria (U)

It is desired that the launcher provide the highest possible degree of functioning reliability, consistent with meeting other requirements, under exposure to adverse environmental conditions of dust.

2.7.3 (U) Method

Three launchers of each model were cleaned, lubricated, and attached to M16A1 rifles. Each launcher was then loaded, the safety placed on the SAFE position, muzzle taped shut, and with 9 rounds of bandoleered ammunition, placed in the dust box and exposed to a blast of dust for 1 minute top side up and for one minute upside down. The dust mixture was as specified in MIL-E-5272C (ASG), commonly referred to as silica flour. The mixture was poured at a rate of five pounds per minute through the pour hole while the blower was turned at an approximate handle speed of 60 rpm. Before firing, the shooter removed the tape from the muzzle and attempted to clean the excess dust from the congested areas on the launcher and ammunition

by shaking, blowing, and wiping with the bare hands. Each launcher was then fired ten rounds. The rounds from the DBCATA launchers were fired to impact on a vertical target at 50 meters in order to determine the influence of dust on the positioning angle of the DBCATA cartridge in the launcher.

2.7.4 (U) Results

The results of the static dust test are given in Table 2.7-I. The dispersion data for the DBCATA launchers are given in Table 2.7-II.

Table 2.7-I (U). Static Dust Test Function Data (U)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1, with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 10.		
Launcher: Pump.		
8	Satis	
10	Satis	
11	Satis	
Launcher: Pivot.		
09	6-FJ	Sand within the ejector-housing made the operation of the ejector sluggish.
10	3-FJ	Same remark as with pivot launcher No. 09.
11	1-FJ	Same remark as with No. 09.
Launcher: DBCATA. Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1015.		
8	1-FJ	
	1-FS	
9	1-FS	
10	3-FJ	
	2-FS	

After-firing inspection revealed only small traces of dust within the trigger housings of any of the launchers. However, the accumulation of sand within the ejector housing of the pivot launcher and around the round retainers of the DBCATA launcher increased friction between operating parts and caused some of the ejection problems.

The inspection also disclosed that slight burring and deformation of the sides of the barrel-lock slot in the ejector housing of the pivot launchers had occurred.

Table 2.7-II (U). Dispersion Data Obtained with the DBCATA Launchers in the Dust Test (50 Meters) (U)

Launcher No.	Deviation, in. Horizontal MR	Horizontal Mean	Horizontal Std	Vertical Mean	Vertical Std	Extreme Dispersion, in. Hor	Vert	Spread
8	5.7	4.3	5.3	3.1	3.9	14.2	12.7	17.0
9	8.0	3.8	4.4	6.1	9.3	11.2	33.3	33.6
10	6.7	3.9	4.8	4.8	6.1	13.3	20.0	20.1
Avg	6.8	4.0	4.8	4.7	6.4	12.9	22.0	23.6

Comparison of the 50-meter dispersion data from Table 2.7-II with that in Table 2.4-III, which was fired with DBCATA launchers under clean field conditions, shows that the accumulation of dust on and around the breech face and round retainers did not cause the dispersion to increase.

2.7.5 (U) Analysis

All three launchers were operable under the conditions of the static dust test; however, the functioning performance of the pump launcher was superior to that of the pivot and DBCATA.

2.8 (U) UNLUBRICATED TEST

2.8.1 Objective

The objective was to determine the functioning performance of the test launchers when in an unlubricated condition.

2.8.2 Criteria

The launcher shall function reliably in an unlubricated condition.

2.8.3 Method

Three launchers of each model were cleaned with quick-drying solvent (PS-661-B), not lubricated, and attached to M16A1 rifles. Each launcher was then fired ten rounds. Since the DBCATA launcher featured automatic ejection and cocking, five of the ten rounds were fired with the weapon held loosely in the hands to determine if variations in rigidity with which the weapon were held influenced these automatic actions.

2.8.4 Results

The function data for the unlubricated test are given in Table 2.8-I.

Table 2.8-I (U). Function Data for Unlubricated Test (U)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1, with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 10. Launcher: Pump.		
8	Satis	The safety could not be moved to the "SAFE" position without first depressing the detent with a small screwdriver.
10	Satis	Same remark as with pump launcher No. 8.
11	Satis	Same remark as with pump launcher No. 8.

Table 2.8-I (Cont'd)

Launcher No.	Function	Remarks
Launcher: Pivot.		
09	3-FJ	
10	2-FJ	
11	4-FJ	The primary sight shifted range setting during firing of the launcher.
Launcher: DBCATA.		
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1017.		
8	3-FJ	
9	8-FS	
10	5-FJ	
	6-FS	

The failure of the safety on the pump launcher was due to binding of the detent in the housing. In moving the safety to the "SAFE" position, the detent must be depressed into the housing of the launcher. The radius of the contact surface between the tip of the detent and the safety was very sharp; consequently, when the gunner attempted to move the safety to the "SAFE" position the action forced the tip of the detent downward and caused the binding action. An application of lubricant to the detent helped to alleviate the problem, but did not correct it completely. The addition of material on the bottom side of the safety assembly to increase the radius of the contact surface with the detent would probably correct the problem.

After-firing inspection of the sight for pump launcher No. 11 disclosed the bracket on the sight arm for the rear aperature to be bent. This was not attributed to the unlubricated condition, but to the fragility of the sight. The angle and manner of the bend indicated that the weapon had been laid on the left side with the rear aperature folded out to the "fire" position.

2.8.5 Analysis

The function performance of the pump launchers was superior to that of the pivot or DBCATA launcher; however, the shortcoming relative to the safety on the pump launcher requires correction.

2.9 (U) WATER SPRAY TEST

2.9.1 Objective

The objective was to determine the effect of simulated heavy rainfall on the functioning performance of the test launchers.

2.9.2 Criteria

Same as for par. 2.72, except that the adverse condition was simulated heavy rain.

2.9.3 Method

Three launchers of each model were cleaned, lubricated and attached to M16A1 rifles. Each launcher was then subjected to a spray of water from a special shower head positioned about 3 feet above the weapon. The spray of water fell at a rate of approximately 0.4 inch per minute or 24 ± 3 inches per hour. The average air and water temperature throughout the test were +75°F and +63°F respectively. While being subjected to the water spray, the launchers were fired as outlined in Table 2.9-I. The ammunition was not subjected to the water spray except for the initial round of each phase which was chambered in the launchers.

Table 2.9-I (U). Firing Sequence for Water-Spray Test (U)

Test Condition	Exposure Time, min	Cumulative Exposure Time, min	Rain, in.	Cumulative Rain in.
Weapon Horizontal				
Launcher empty, breech closed	5	5	2.0	2.0
Loaded	5	10	2.0	4.0
Fire 5 rounds	4	14	1.6	5.6
Launcher empty, breech closed	5	19	2.0	7.6
Loaded	5	24	2.0	9.6
Fire 5 rounds	4	28	1.6	11.2
Weapon Muzzle Up				
Launcher empty, breech closed	5	33	2.0	13.2
Loaded	5	38	2.0	15.2
Fire 5 rounds	4	42	1.6	16.8

Table 2.9-I (Cont'd)

Test Condition	Exposure Time, min	Cumulative Exposure Time, min	Rain, in.	Cumulative Rain in.
Launcher empty, breech closed	5	47	2.0	18.8
Loaded	5	52	2.0	20.8
Fire 5 rounds	4	56	1.6	22.4
Weapon Muzzle Down				
Launcher empty, breech closed	5	61	2.0	24.4
Loaded	5	66	2.0	26.4
Fire 5 rounds	4	70	1.6	28.0
Launcher empty, breech closed	5	75	2.0	30.0
Loaded	5	80	2.0	32.0
Fire 5 rounds	4	84	1.6	-

2.9.4 Results

The function data for the water spray test are given in Table 2.9-II.

Table 2.9-II (U). Function Data for Water Spray Test (U)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1, with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 30. Launcher: Pump.		
8	Satis	Safety could be operated with no problem.
10	Satis	The safety could not be moved to the "SAFE" position at the start of the test but approximately half way through the exercise it could be operated.
11	Satis	The safety could not be moved to the "SAFE" position except with use of a screwdriver to depress the detent.
Launcher: Pivot.		
09	9-FJ	
10	3-FJ	

Table 2.9-II (Cont'd)

Launcher No.	Function	Remarks
11	16-FJ 1-FFR	The failure to fire occurred in the first cycle of five rounds. The firing pin was striking high on the primer at the 12 o' clock position. The rear bracket was loosened and the indents thereafter were lower, but still slightly off center.
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1015. Launcher: DBCATA.		
8	Satis	
9	1-FS	
10	1-FJ 1-FS 2-FFR	Both failures to fire occurred on the first round after a conditioning period. The first occurred in the muzzle up position and the second in the muzzle down position. The indents in both rounds appeared to be light, but neither would fire on second attempts.

After-firing inspection revealed the safety-detent spring on pump launcher No. 11 to be kinked. A new spring was assembled but the safety still could not be actuated. A new safety assembly was installed which alleviated the problem, but did not correct it entirely.

2.9.5 Analysis

All three launchers were operable under the conditions of the water spray test, but the functioning performance of the pump was superior to that of the pivot and DBCATA launchers.

2.10 (U) DYNAMIC DUST TEST

2.10.1 Objective

The objective was to determine the functioning performance of the test launchers under conditions of blowing dust.

2.10.2 Criteria

Same as for par. 2.7.2.

2.10.3 Method

Three launchers of each model were cleaned, lubricated, and attached to M16A1 rifles. Each launcher was loaded, the safety placed on the SAFE position and with 14 rounds of ammunition in bandoleers placed in the dynamic dust chamber. The weapons and ammunition were then exposed to blowing dust which was introduced into the dust chamber at an approximate rate of two pounds per minute. The blower was turned at a handle speed of 60 rpm. Each launcher was then fired 15 rounds employing a rate of fire of approximately one round each ten seconds which made a total time in the blowing dust of approximately 2-1/2 minutes provided no problems were encountered. The dust mixture was the same as that described in paragraph 2.7.3.

2.10.4 Results

The function data recorded during the dynamic dust test are given in Table 2.10-I.

Table 2.10-I (U). Function Data for Dynamic Dust Test (U)

Launcher No.	Function	Total Time in Dust Min	Total Time in Dust Sec	Remarks
Ammunition: Cartridge, 40-mm, M407A1 with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 15. Launcher: Pump.				
8	Satis	2	30	After completion of the test the safety could not readily be moved to the SAFE position until after several attempts were made.
10	Satis	2	30	The safety functioned properly.
11	Satis	2	30	The safety functioned properly.

Table 2.10-I (Cont'd)

Launcher No.	Function	Total Time in Dust Min	Sec	Remarks
Launcher: Pivot.				
09	5-FER 7-FJ	3	30	The test was stopped after three attempts were made to fire the eleventh round. Prior to this time four other occurrences of the same malfunction had been experienced. Inspection of the launcher showed the ejector to be in the forward position. The chambered round and the other four rounds which had been ejected after attempts to fire disclosed no trace of firing pin indent.
10	4-FJ	2	30	
11	5-FJ	2	36	
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1015. Launcher: DBCATA.				
8	5-FJ	2	30	
9	Satis	2	30	
10	11-FJ 1-FS 1-FFR	3	05	Three attempts were made to fire one round. In each instance the firing pin moved forward, but failed to indent the primer. Inspection revealed the round to be assembled under only one round retainer. The malfunction was charged to personnel error.

After-test inspection of the trigger-housings disclosed very little dust within the housing of any of the launchers. However, the inside of the ejectors on the pivot launchers were coated with dust.

2.10.5 Analysis

The malfunction performance of the three launchers showed that only the pump launcher functioned reliably under conditions of blowing dust.

2.11 (U) MUD TEST

2.11.1 (U) Objective

The objective was to determine the functioning performance of the test launchers after being subjected to adverse conditions of mud.

2.11.2 (U) Criteria

Same as in paragraph 2.7.2, except that the adverse condition was mud.

2.11.3 (U) Method

Three launchers of each model were cleaned, lubricated, and attached to M16A1 rifles. Each launcher was loaded, the safety placed on the SAFE position, and with the muzzle taped shut submerged in a mud mixture for 60 seconds. The mud mixture consisted of ten pounds of red clay to two pounds of clean river sand to eight quarts of water. Prior to firing, an attempt was made to clean the weapon by wiping with the bare hands and jarring. An attempt was then made to fire ten rounds. The ammunition was not subjected to the mud except for the initial round which was chambered in the launcher.

2.11.4 (U) Results

The function data recorded during the mud test are given in Table 2.11-I.

Table 2.11-I (U). Function Data for Mud Test (U)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1 with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 10. Launcher: Pump.		
8	Satis	The safety was actuated once and then the detent plunger could not be depressed without the use of a small screwdriver.
10	Satis	Same remark as with pump launcher No. 8.
11	Satis	Same remark as with pump launcher No. 8.
Launcher: Pivot.		
09	2-FER 2-FRT 1-CLF 2-FJ	The failures of the ejector to return occurred with the loading of the second and third round. The trigger could not be pulled to fire the third round. At this time the weapon was turned upside down and approximately a quart of water was poured into and on the bottom of the trigger housing. The trigger was still difficult to pull, but could be actuated.
10	3-FJ 5-CLF	The trigger was very difficult to pull and the launcher barrel was hard to pivot.
11	2-FJ 6-CLF	The trigger could not be pulled to fire the ninth round. As with launcher No. 9, approximately a quart of water was poured into and on the bottom of the trigger housing. The round was then fired.

Table 2.11-I (Cont'd)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1015. Launcher: DBCATA.		
8		The initial round fired, ejected, and the firing pin seared. The second round was loaded, but the sear would not release the firing pin when the trigger was pulled. Approximately a quart of water was poured over the breech and trigger of the launcher, and the charging handle was pulled rearward several times, but the sear still would not release the firing pin with the actuation of the trigger. The test was terminated.
9		Same remark as with DBCATA launcher No. 8.
10		Same remark as with DBCATA launcher No. 8.

After-test inspection of the inside of the housings of the launchers disclosed only slight traces of mud in the pump launcher and heavy concentrations in the pivot and DBCATA launchers. The difficulty with the trigger and cocking levers on the pivot launcher was attributed to mud on and around the sear and cocking shaft and between the top of the trigger and the launcher housing. The mud between the top of the trigger and the launcher housing prohibited movement of the trigger and required the gunner to pull the trigger several times in order to cause the sear to release the hammer. The failure of the DBCATA launchers was attributed to mud between the contact surfaces of the sear and the firing pin which prohibited the release of the firing pin with actuation of the trigger.

As in the static dust test, par. 2.7, plans were to target the DBCATA launchers at 50 meters with the launcher in a muddy condition. However, due to termination of the test after the firing of one round this could not be accomplished.

2.11.5 Analysis

The design of the pivot and DBCATA launchers was such as to permit ready entry of mud into vital working parts, with consequent deleterious effects an operation. The pump launcher design was superior to the other two models in this respect.

2.12 (U) SALT-WATER IMMERSION TEST

2.12.1 Objective

The objective was to determine the deleterious effects of immersion in salt water on weapon performance.

2.12.2 Criteria

Same as in par. 2.7.2, except that the adverse condition was immersion in salt water.

2.12.3 Method

Three launchers of each model were cleaned and lubricated. Each launcher was then submerged in a salt-water solution for 60 seconds. The solution was composed of 20 per cent salt to 80 per cent water, by weight. The salt did not contain more than 0.1 per cent sodium iodide nor more than 0.2 per cent impurities. After removal from the salt water, each launcher was attached to an M16A1 rifle, fired 5 rounds, and then exposed to the heat and humidity conditions as shown in Table 2.12-I for a period of ten days. Within the 10-day period, additional 5-round complements were fired on the third, fifth, eighth, and tenth days without the aid of cleaning or additional lubricant. The ammunition was not immersed in the salt-water solution.

Table 2.12-I (U). Heat-Humidity Storage Schedule (U)

No. Hrs	Temperature, ^{o}F	Relative Humidity
2	Increase to +105	85 to 90
16	Maintain at +105 ± 3	85 to 90
2	Decrease +105 to 70	95 ± 2
4	Maintain at +70 ± 3	95 ± 2

One of the three launchers of each model was stored with a round chambered and an attempt was made to fire this round without prior removal from the launcher chamber. The other two launchers of each model were stored in an unloaded condition.

2.12.4 Results

The function data recorded during the salt-water immersion test are given in Table 2.12-II.

Table 2.12-II (U). Function Data for Salt-Water Immersion Test (U)

Launcher No.	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1 with dummy fuze, lot MA-SP-516. No. of Rounds Fired per Launcher: 25. Launcher: Pump.		
8	Satis	
10	Satis	
11	Satis	
Launcher: Pivot.		
09	9-FJ	
10	2-FFRL	The failures to fire occurred on the fifth and tenth days with the first round which was stored in the chamber of the launcher[a].
	10-FJ	
11	1-FFRL	The failure to fire occurred on the first round of the test. The indent in the primer was extremely high at the 12 o'clock position. The rear barrel bracket was loosened which centered the primer indent on subsequent rounds. The failure to fire was charged to personnel error.
	10-FJ	
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, practice, lot 51303-1015. Launcher: DBCATA		
8	2-FFRL	The primers in both rounds were deeply indented. One occurred on the eighth day and the other on the tenth day.
	3-FS	
9	4-FS	
10	Satis	

[a]Both rounds had light indents in the primers and fired on the second attempt. The malfunctions were attributed to water accumulation in the plunger assembly which created a hydrostatic condition within the assembly. This did not occur with the other two pivot launchers because the cocking levers were depressed in the loading-action and this actuated the plunger and forced the water from the assembly.

After-test inspection of the launchers disclosed the working parts within the trigger housing of the pump launcher to have a severe concentration of rust. Particularly, the firing-pin spring showed a heavy build-up of corrosion with marked pitting and etching. The cocking lever showed some etching through the plating in the area where the arms of the lever straddle the firing pin. A heavy accumulation of rust was present within the firing pin well, but this was attributed to contact with the firing pin spring. Additionally, on the pump launcher, the front barrel bracket was approximately 80% rust covered with some pitting and the heads of the retaining screws for the sight base and the knob on the mounting screw were 75% rust covered with pitting and etching.

No rust was found on the parts within the trigger housings of the pivot and DBCATA launchers. The only rust found on the pivot was on the heads of screws and on the barrel brackets. The surface area of the round retainers on the DBCATA launcher was 10% rust covered with slight pitting. The breech buttons and the heads of the retainer screws were 50% rust covered with some etching. The sight on the DBCATA launcher being of the same design as that for the pump showed rust in a similar manner.

2.12.5 Analysis

The pump launcher experienced more rust accumulation on working parts than did either the pivot or DBCATA launchers. The functioning reliability, of the pump launcher, however, was superior to that of either of the other two models.

2.13 RELIABILITY AND DURABILITY (U)

2.13.1 (U) Objectives

The objectives were:

a. To determine the reliability of the test launchers.

b. To determine if the attachment and use of the test launchers, particularly extended use, is detrimental to the M16A1 rifle.

2.13.2 Criteria (U)

a. (C) The launcher shall be capable of firing at least 1000 rounds without incurring broken or unserviceable parts.

b. (U) The attachment and subsequent use of the launcher shall not be detrimental to the accuracy or function performance of the M16A1 rifle.

2.13.3 (U) Method

Three launchers of each model were attached to M16A1 rifles and fired 1000 rounds each. The rounds previously fired for velocity were counted as part of the 1000-round total. After each 200 rounds of firing, all launchers were cleaned and lubricated, and the following measurements were recorded:

a. Cocking or charging force.

b. Safety actuation force.

c. Firing-pin indent.

d. Firing-pin energy.

e. Firing-pin protrusion.

f. Trigger pull.

Additionally, velocity measurements of the first and last ten rounds of each 200-round group were obtained. The ammunition fired for velocity was temperature conditioned at +70° ± 2°F.

Also, at the beginning of each 200-round cycle, the launcher and rifle to which the launcher was attached were fired alternately for 20 rounds in order to determine the occurrence of rifle failures to fire and failures to remain seared due to recoil imparted to the rifle from firing the launcher. For the foregoing firing the rifle selector was set on semiautomatic. The procedure was then repeated with the rifle selector set on automatic, but no attempt was made to fire the rifle until after 20 rounds had been fired with the attached launcher. After each 100 rounds of firing with the launcher, the rifle was fired 100 rounds semiautomatically and 100 rounds automatically.

Since the DBCATA launcher features automatic ejection and cocking 20 rounds of the 100-round test were fired with the weapon held at various attitudes to determine the effects on the automatic actions. The various positions are as follows:

a. Held loosely in the hands.

b. Held normally at an elevation of 45 degrees.

c. Held loosely at an elevation of 45 degrees.

d. Held normally at a depression of 80 degrees.

e. Held loosely at a depression of 80 degrees.

Prior to the test, after firing 500 rounds, and following completion of 1000 rounds of firing with the launchers, three 10-round accuracy groups were fired at 100 meters with each of the rifles and at 50 meters with each of the launchers.

2.13.4 Results (U)

(U) The function data recorded for the three types of launchers during the 1000-round reliability test are given in Tables 2.13-I, -II, and -III. Included in the tables are the rifle failures to fire and failures to remain seared which occurred due to recoil imparted to the rifle from firing the launcher. The M16A1 rifle performance data obtained during the launcher reliability test, excluding those rifle malfunctions considered attributable to the attached launcher are summarized in Table 2.13-X.

(U) The launcher measurements recorded at the start of the test and after each 200-round group of the 1000-round test are summarized in Table 2.13-IV. The velocity performance of the pump and pivot launchers throughout the test are summarized in Table 2.13-V and the velocity data for the DBCATA launcher are given in Table 2.13-VI. The accuracy data obtained with the launchers and rifles at the beginning of test, at the 500-round stage and after test are given in Tables 2.13-VII and -VIII.

Table 2.13-I (U). Function Data for Pump Launcher (U)

Pump Launcher 14				Pump Launcher 15				Pump Launcher 16			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1 with dummy fuze, lot MA-SP-516.											
40	40	2-FX	See note [a].	20	20	Satis		20	20	1-FFRL	
At this time new extractors with a negative-angle hook were assembled in the pump launchers. Also, the barrel bracket screws were replaced with longer screws in an attempt to stop deformation of the screws.											
160	200	1-FFRL		180	200	1-FFRL		180	200	2-FFRL	The launcher sight came loose once.
The launchers were disassembled, cleaned, and inspected.											
78	278	5-FX 2-FFRR	See note [b].	200	400	2-FFRL 1-FFRR 1-PPO		200	400	1-FFRL	The launcher sight came loose once.
122	400	3-FX									
The launchers were disassembled, cleaned, and inspected.											
200	600	5-FX 5-FFRR	The launcher sight came loose four times.	200	600	1-FFRL 14-PPO		200	600	1-FFRL	
The launchers were disassembled, cleaned, and inspected.											
82	682	14-FX	The launcher sight came loose once. See note [c].	200	800	43-PPO		200	800	Satis	The launcher sight came loose twice.
66	748	3-FX	See note [d].								

[a] On one occasion the safety could not be moved to the SAFE position. The Code AA representative forced the safety to actuate. The malfunction was attributed to a burr within the safety-detent housing.

[b] Inspection disclosed the extractor to be loose in the launcher housing. The dowel pin which retained the extractor was replaced with a spring pin in an attempt to tighten the extractor.

[c] In an attempt to stop the occurrence of failures to extract, the Code AA representative widened the extractor slot in the handgrip and barrel and relieved the trigger guard at the point of contact with the extractor. Additionally, a new extractor pin was installed which decreased the headspace from 0.090-inch to 0.085-inch.

[d] The handgaurd came loose and slid forward along the barrel approximately 6 inches when the gun was fired. The AA representative cleaned the inside of the handguard and reglued it to the barrel.

Table 2.13-I (Cont'd)

Pump Launcher 14				Pump Launcher 15				Pump Launcher 16			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
2	750	2-FX	Inspection of the extractor spring disclosed it had taken a set of approximately 1/16-inch. A new spring was assembled.								
50	800	1-FX	The launcher sight came loose once.								
The launchers were disassembled, cleaned, and inspected.											
52	852	4-FX	A new extractor spring was assembled.	240	1040	1-FX 49-PPO		240	1040	1-FFRL	
188	1040	Satis									
Total Malfunctions		39-FX 1-FFRL 7-FFRR				1-FX 4-FFRL 107-PPO 1-FFRR				6-FFRL	
Malfunction Rate/100 Rounds Fired[a]		3.8				0.5				0.6	

[a]These rates do not include partial punchouts of primer or rifle malfunctions.

Table 2.13-II (U). Function Data for the Pivot Launchers (U)

Pivot Launcher 02				Pivot Launcher 03				Pivot Launcher 08			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
Ammunition: Cartridge, 40-mm, M407A1 with dummy fuze, lot MA-SP-516.											
4	4	1-FFRL		11	11	Satis		-	-		
At this time the launcher housings were modified by the manufacturer with the addition of a second barrel bracket in an attempt to strengthen the frame of the launcher. The added part is shown in Figure 2.2-2 as Part No. 3.											
196	200	1-FFRL 1-FFRR		189	200	3-FFRL 3-IAVF 1-FFRR	See note [a].	200	200	1-FFRL 1-IAVF 2-FFRR	See note[a].
The launchers were disassembled, cleaned, and inspected.											
200	400	2-FFRL 10-FJ				1-FFRL 11-FJ		200	400	1-FFRL 50-FJ 13-PPO	
The launchers were disassembled, cleaned, and inspected.											
200	600	2-FFRL 23-FJ	See note[b].			2-FFRL 22-FJ 1-FFRR	See note [b].	200	600	46-FJ 8-PPO	

[a] In each instance the gunner pulled the trigger on the launcher and the hammer failed to fall, but with subsequent slight movement of the barrel the launcher fired. The inadvertent firings were attributed to engagement between the barrel lock and the step-like sides of the barrel-lock slot in the ejector housing, which prevented proper positioning of the lock. Further discussion of the deficiency is contained in paragraph 2.3.4 under the safety examination subtest.

[b] The flexible leaf spring in the primary sight assembly developed cracks around the front retaining rivet. This allowed the leaf spring to lose tension. Consequently, the front sight post failed to return to position after a round was fired.

Table 2.13-II (Cont'd)

Pivot Launcher 02				Pivot Launcher 03				Pivot Launcher 08			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
200	800	37-FJ 1-FER 1-PPO		200	800	16-FJ		200	800	33-FJ 7-PPO	The gunner pinched his hand between the rim of the case and the rear of the ejector.
The weapons were disassembled, cleaned, and inspected.											
245	1045	6-FFRL 55-FJ	See note [c].	240	1040	1-IAVF 59-FJ		243	1043	107-FJ 10-PPO	
Total malfunctions		125-FJ 12-FFRL 1-FER 1-PPO 1-FFRR				108-FJ 6-FFRL 4-IAVF 2-FFRR				230-FJ 2-FFRL 1-IAVF 38-PPO 2-FFRR	
[d] Stoppage Rate/100 rds fired[d]		13.2				11.3				22.3	

[c] Wear and deformation in the barrel-lock slot in the bottom of the ejector housing allowed excessive movement in the barrel when in the locked position. The movement was sufficient to cause the firing pin to impact on the edge of the base plug and extreme edge of the primer at approximately the 9 o'clock position. All six failures-to-fire fired on the second attempt.

[d] These rates do not include partial punchouts of the primer or rifle malfunctions.

Table 2.13-III (U). Function Data for the DBCATA Launchers (U)

DBCATA 14				DBCATA 15				DBCATA 16			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, lot 51303-1017.											
50	50	20-FS	On two occasions the handguards came loose with recoil of the launcher.	53	53	23-FS		51	51	Satis	On one occasion during the 50-meter accuracy test the sight shifted to 75 meters and the round went over the target at 50 meters.
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, lot 51303-1018.											
150	200	72-FS 1-FFRL 27-FFRR		72	125	10-FS 1-FJ 31-FFRR	The sight shifted in range setting several times with recoil of the launcher. Also, on several occasions the handguards came loose with the recoil of the launcher.	49	100	31-FS 15-FFRR	
				75	200	1-FFRL		100	200	1-RTC	The launcher sight came loose once.
At this time the three DBCATA launchers in the reliability test were modified by the manufacturer with the addition of a firing-pin-stop to correct the failure to sear malfunction. The modification to the launcher and the additional parts are shown in Figures 2.13-1 and 2.13-2.											
200	400	2-FS 2-RTC	On four occasions the front sight on the launcher folded rearward with recoil of the launcher. The flash from one of the ruptured telescoping cups singed the gunner's left hand.	200	400	9-FJ 3-FS 1-RTC 1-FFRR	The handguards continually came loose during recoil of the launcher. Also, the launcher sight came loose several times and the stud on the launcher sight housing.	20	220	5-FS 1-FFRR	The firing-pin-stop was removed and the actuator spring for the stop was replaced.

Table 2.13-III (Cont'd)

DBCATA 14				DBCATA 15				DBCATA 16			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
							which positions the sight on the rifle carrying handle was sheared.				
								180	400	1-FFRL 2-RTC	The launcher sight loose on two occasions.
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, lot 51303-1020.											
40	440	3-FS	All three failures to sear occurred in succession. The firing-pin-stop was lubricated.	200	600	5-FS 1-RTC	The handguards continually came loose during recoil of the launcher.	200	600	2-FS 2-RTC	The launcher sight came loose three times. The firing-pin-stop was lubricated after the second failure to sear occurred.
91	531	7-FS 1-IAVF	See note[a].								
69	600	6-FS									
The launchers were disassembled, cleaned, and inspected.											
200	800	1-FS 2-RTC		200	800	3-FS 2-RTC	The handguards constantly came loose during recoil of the launder. Also, the launcher sight came loose several times.	200	800	1-FS 2-RTC	The launcher sight came loose two times.

[a]When the gunner loaded the launcher, the round fired. This was attributed to failure of the primary sear to engage the firing pin when the firing-pin-stop was released with the loading of the round. The Code AA representative modified the launcher by replacing the 0.016-inch diameter wire sear spring with an 0.022-inch diameter spring of the same length.

Tabel 2.13-III (Cont'd)

DBCATA 14				DBCATA 15				DBCATA 16			
No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks	No. Rds Fired	Total Rds Fired	Function	Remarks
The launchers were disassembled, cleaned, and inspected.											
194	994	7-FS 2-FFRR 2-FRRS		190	990	13-FS 3-FJ 3-FRRS		190	990	1-FS 1-RTC 3-FFRR	The retainer ring on the front barrel bracket insulator broke and a piece fell out through the vents in the handguard.
Ammunition: Cartridge, 40-mm, DBCATA, M407A1, lot 51303-1017.											
22	1016	Satis	Velocity check.	20	1010	Satis		22	1012	Satis	
[b]Total malfunctions		26-FS 1-IAVF 1-FFRL 4-RTC 29-FFRR 2-FRRS				24-FS 13-FJ 1-FFRL 4-RTC 32-FFRR 3-FRS				9-FS 2-FFRL 8-RTC 19-FFRR	
Stoppage Rate/100 rds Fired[c]		2.8				3.8				1.1	

[b]The totals do not include the failure to sear malfunctions which occurred prior to the modification of the launchers with the addition of a firing-pin-stop.
[c]These rates do not include ruptured telescoping cups or rifle malfunctions.

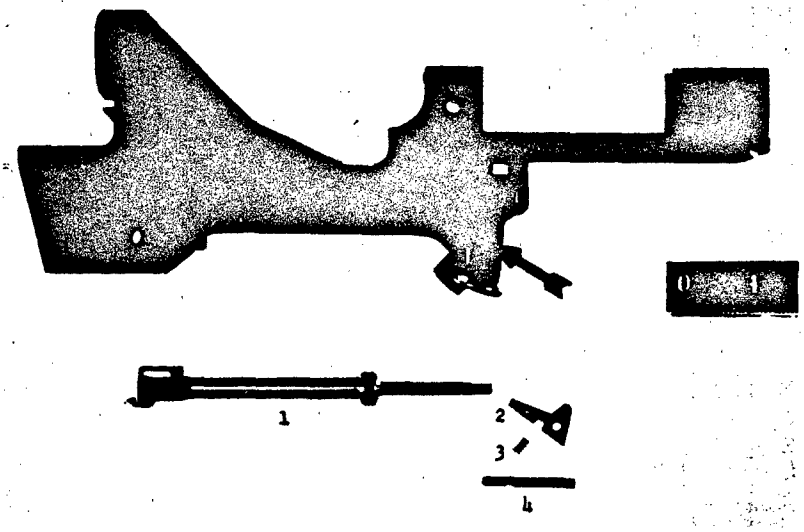


Figure 2.13-1 (C): Parts for Firing-Pin-Stop. (1) Modified Firing Pin. (2) Firing-Pin-Stop. (3) Spring. (4) Dowel Pin. The Arrow Indicates the Hole in the Launcher Housing for the Dowel Pin Which Retains the Firing-Pin-Stop (U).

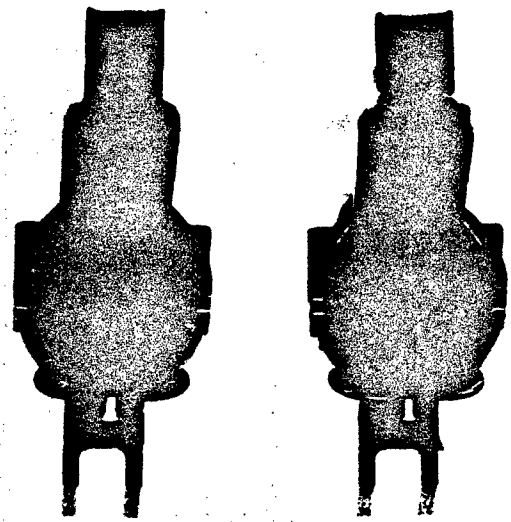


Figure 2.13-2 (C): LEFT: View of the Face of the Breech on a DBCATA Launcher as Initially Received for Test. RIGHT: View Showing the Slot (Arrow) Which Was Cut for the Installation of the Firing-Pin-Stop (U).

Table 2.13-IV (U). Launcher Measurements Recorded throughout the Reliability Test (U)

Launcher Type	Launcher No.	Safety Actuation Force, lb Mean	Safety Actuation Force, lb Max	Safety Actuation Force, lb Min	Cocking Force, lb Mean	Cocking Force, lb Max	Cocking Force, lb Min	Trigger Pull, lb Mean	Trigger Pull, lb Max	Trigger Pull, lb Min	Firing Pin Indent, in.[a] Mean	Firing Pin Indent, in.[a] Max	Firing Pin Indent, in.[a] Min	Firing Pin[a] Energy, in.-oz	Firing Pin Protrusion, in.
Rounds Fired: Before test.															
Pump	14	1.5	2.2	1.0	10.3	10.5	10.1	7.9	8.3	7.5	0.0109	0.0111	0.0108	29.5	0.065
Pump	15	1.0	1.2	0.9	7.8	8.1	7.7	6.2	6.5	6.0	.0110	.0112	.0108	30.0	.072
Pump	16	0.6	0.9	0.5	11.4	11.7	11.0	6.8	7.0	6.6	.0115	.0118	.0111	33.0	.057
Pivot	2	3.3	3.5	3.0	8.7	8.9	8.4	13.5	14.0	13.2	.0140	.0145	.0133	48.5	.052
Pivot	3	5.5	6.0	5.2	7.7	8.0	6.8	13.7	14.0	13.5	.0131	.0133	.0130	42.5	.072
Pivot	8	4.7	5.0	4.2	9.0	9.1	8.9	13.8	14.5	13.5	.0153	.0155	.0151	58.2	.056
DBCATA	14	5.6	5.9	5.2	14.8	15.0	14.0	4.8	5.0	4.6	-	-	-	-	.055
DBCATA	15	2.1	2.4	1.9	19.0	20.0	18.0	5.5	5.5	5.4	-	-	-	-	.057
DBCATA	16	2.9	3.1	2.7	15.3	16.0	14.5	5.3	5.5	5.0	-	-	-	-	.059
Rounds Fired: 200[c].															
Pump	14	[b]1.2	1.8	1.2	10.1	10.3	10.0	6.2	6.5	6.0	.010	.010	.009	27.2	.065
Pump	15	1.7	2.2	1.2	7.3	7.5	6.5	5.0	5.0	5.0	.010	.012	.010	27.7	.073
Pump	16	0.7	0.8	0.5	9.8	10.5	10.0	5.8	6.0	5.5	.011	.011	.010	34.5	.058
Pivot	2	2.5	3.0	2.0	8.7	10.0	7.5	13.6	15.0	13.0	.012	.013	0.11	36.2	.051
Pivot	3	3.7	4.0	3.5	7.6	8.0	7.0	13.0	13.5	12.8	.011	.011	.011	31.3	.075
Pivot	8	3.9	4.0	3.5	8.1	9.0	7.0	15.8	16.0	15.5	.015	.015	.014	55.9	.060
Rounds Fired: 400[c].															
Pump	14	1.3	1.7	1.2	9.4	9.5	9.3	5.9	6.2	5.8	.010	.010	.009	27.7	.065
Pump	15	1.1	1.3	0.8	7.2	7.5	7.0	5.1	5.5	4.5	.010	.010	.011	27.7	.072
Pump	16	0.7	1.0	0.6	8.7	9.0	8.6	4.8	5.5	4.3	.010	.010	.009	27.7	.058

[a]The initial firing pin indent measurements were determined from copper-crusher cylinders which were indented at APG and forwarded to AMSWE-RDSR for determination of indent depth and firing pin energy. Thereafter, the indent depths were measured at APG and the firing pin energy determined from a graph provided by AMSWE-RDSR.
[b]Actuation of the detent was sometimes difficult which would force the reading as high as 7 or 8 pounds. These data were excluded.
[c]The measurements for the DBCATA launchers were inadvertently omitted at the 200 and 400 round stages.

Table 2.13-IV (Cont'd)

Launcher Type	Launcher No.	Safety Actuation Force, lb Mean	Safety Actuation Force, lb Max	Safety Actuation Force, lb Min	Cocking Force, lb Mean	Cocking Force, lb Max	Cocking Force, lb Min	Trigger Pull, lb Mean	Trigger Pull, lb Max	Trigger Pull, lb Min	Firing Pin Indent, in.[a] Mean	Firing Pin Indent, in.[a] Max	Firing Pin Indent, in.[a] Min	Firing Pin[a] Energy, in.-oz	Firing Pin Protrusion, in.
Pivot	2	2.5	2.6	2.4	8.0	8.7	7.1	12.8	13.8	12.3	0.011	0.012	0.011	31.3	0.053
Pivot	3	3.6	3.8	3.4	8.1	8.3	7.9	13.2	14.0	13.0	.012	.012	.012	36.2	.071
Pivot	8	4.3	4.4	4.2	8.9	9.0	8.7	15.5	16.0	15.0	.014	.014	.014	47.3	.061
Rounds Fired: 600.															
Pump	14	1.6	2.0	1.0	9.0	9.0	9.0	5.2	6.0	5.0	.009	.010	.008	21.2	.065
Pump	15	1.3	2.5	1.0	7.7	8.0	7.5	5.0	5.0	5.0	.010	.011	.010	27.7	.070
Pump	16	0.4	0.5	0.3	9.0	9.0	9.0	5.0	5.0	5.0	.011	.011	.010	34.5	.058
Pivot	2	2.4	2.5	2.0	8.3	9.0	8.0	12.8	13.0	12.0	.011	.012	.011	31.3	.052
Pivot	3	3.0	3.0	3.0	8.1	8.5	8.0	15.0	15.0	15.0	.011	.011	.010	31.3	.077
Pivot	8	4.1	4.5	4.0	8.1	8.5	7.0	15.7	16.0	15.0	.014	.014	.014	47.3	.061
DBCATA	14	2.0	2.1	2.0	13.1	13.2	13.0	8.1	8.5	7.5	-	-	-	-	.057
DBCATA	15	1.8	2.0	1.6	14.0	14.3	13.8	8.9	9.2	8.6	-	-	-	-	.056
DBCATA	16	2.1	2.4	2.0	13.0	13.2	12.6	9.8	11.7	8.6	-	-	-	-	.057
Rounds Fired: 800.															
Pump	14	-[d]			10.0	10.5	9.8	5.9	6.2	5.4	.010	.011	.009	27.7	.066
Pump	15	1.9	2.2	1.4	7.7	7.9	7.6	5.5	5.8	5.0	.010	.011	.009	27.7	.073
Pump	16	0.6	0.6	0.5	9.2	9.5	9.1	5.3	5.8	5.0	.010	.011	.009	27.7	.058
Pivot	2	2.3	2.9	1.9	8.0	8.5	7.0	13.4	13.6	12.7	.012	.012	.011	36.2	.052
Pivot	3	3.5	3.6	3.2	8.0	8.4	7.4	12.7	13.0	12.3	.012	.012	.011	36.2	.077
Pivot	8	4.5	4.8	4.2	8.5	8.7	8.4	15.3	15.6	14.8	.014	.014	.014	47.3	.062
DBCATA	14	1.9	2.0	1.8	13.7	16.0	13.0	8.2	9.0	6.8	-	-	-	-	.057
DBCATA	15	1.8	2.0	1.5	14.0	14.3	13.6	8.8	9.0	8.5	-	-	-	-	.056
DBCATA	16	2.2	2.5	2.0	12.7	13.0	12.0	9.8	10.4	9.4	-	-	-	-	.057

[a]The initial firing pin indent measurements were determined from copper-crusher cylinders which were indented at APG and forwarded to AMSWE-RDSR for determination of indent depth and firing pin energy. Thereafter, the indent depths were measured at APG and the firing pin energy determined from a graph provided by AMSWE-RDSR.
[d]The safety detent was binding excessively, prohibiting the movement of the safety to the SAFE position.

Table 2.13-IV (Cont'd)

Launcher Type	Launcher No.	Safety Actuation Force, lb Mean	Safety Actuation Force, lb Max	Safety Actuation Force, lb Min	Cocking Force, lb Mean	Cocking Force, lb Max	Cocking Force, lb Min	Trigger Pull, lb Mean	Trigger Pull, lb Max	Trigger Pull, lb Min	Firing Pin Indent, in.[a] Mean	Firing Pin Indent, in.[a] Max	Firing Pin Indent, in.[a] Min	Firing Pin[a] Energy, in.-oz	Firing Pin Protrusion, in.
Rounds Fired: 1000.															
Pump	14	[d] -			9.4	9.6	9.3	5.3	5.5	5.1	0.010	0.011	0.009	27.7	0.065
Pump	15	1.0	1.1	0.8	7.7	7.8	7.7	5.4	6.2	5.0	.010	.011	.010	27.7	.073
Pump	16	0.7	0.8	0.6	9.0	9.7	8.6	5.6	6.0	5.3	.010	.010	.009	27.7	.058
Pivot	2	2.7	2.9	2.5	8.5	8.6	8.3	14.4	15.5	13.5	.012	.012	.012	36.2	.053
Pivot	3	3.9	4.4	3.6	7.8	8.0	7.2	16.8	17.0	16.5	.011	.012	.011	31.3	.077
Pivot	8	4.7	5.1	4.4	8.7	8.9	8.5	16.0	16.5	15.5	.014	.014	.013	47.3	.062
DBCATA	14	1.4	1.5	1.2	12.9	13.5	12.5	9.8	12.0	9.0	-	-	-	-	.057
DBCATA	15	1.8	2.2	1.5	13.8	14.0	13.5	9.2	9.8	8.8	-	-	-	-	.056
DBCATA	16	2.0	2.3	1.8	12.7	13.0	12.0	11.2	13.0	10.0	-	-	-	-	.057

[a]The initial firing pin indent measurements were determined from copper-crusher cylinders which were indented at APG and forwarded to AMSWE-RDSR for determination of indent depth and firing pin energy. Thereafter, the indent depths were measured at APG and the firing pin energy determined from a graph provided by AMSWE-RDSR.
[d]The safety detent was binding excessively, prohibiting the movement of the safety to the SAFE position.

Table 2.13-V (U). Velocity Data Recorded During Reliability Test with the Pump and Pivot Launchers (U)

Pump Launcher Velocities, fps							Pivot Launcher Velocities, fps						
	Avg IV 20 Feet from			Variations				Avg IV 20 Feet from			Variations		
Launcher No.	Muzzle	Max	Min	Mean	Extreme	Std Dev	Launcher No.	Muzzle	Max	Min	Mean	Extreme	Std Dev
Cartridge: 40-mm, M407A1, with dummy fuze, lot MA-SP-516.													
Condition[a]: Start of test.													
AA14	245.6	249.7	240.9	2.0	8.8	2.5	AN2	240.4	243.9	236.9	2.4	7.0	2.6
AA15	245.4	248.4	242.6	1.7	5.8	1.9	AN3	234.5	237.2	230.1	1.7	7.1	2.1
AA16	244.0	246.3	241.2	1.0	5.1	1.3	AN8	235.2	239.7	229.9	2.2	9.8	2.7
Avg	245.0			1.6	6.6	1.9	Avg	236.7			2.1	8.0	2.5
Round Nos. 191 to 200.													
AA14	245.1	248.7	242.1	2.0	6.6	2.5	AN2	237.9	252.6	232.7	3.5	19.9	5.7
AA15	242.9	246.9	237.8	1.8	9.1	2.5	AN3	237.3	242.7	231.6	2.9	11.1	3.7
AA16	243.7	246.4	239.4	1.9	7.0	2.4	AN8	234.6	238.5	230.2	2.2	8.3	2.8
Avg	243.9			1.9	7.6	2.5	Avg	236.6			2.9	13.1	4.1
Round Nos. 201 to 210.													
AA14	241.6	244.9	239.5	1.4	5.4	1.8	AN2	233.2	234.9	229.2	1.2	5.7	1.7
AA15	240.6	243.9	235.7	2.2	8.2	2.8	AN3	233.5	238.0	229.5	2.0	8.5	2.7
AA16	237.9	241.6	230.0	1.9	11.6	3.1	AN8	231.8	236.0	229.2	1.2	6.8	1.8
Avg	240.0			1.8	8.4	2.6	Avg	232.8			1.4	7.0	2.1

[a]The velocity data for "start of test" are extracted from Table 2.4-I and are an average of 20 rounds per launcher; whereas, the other velocities in this table are an average of 10-round groups.

Table 2.13-V (Cont'd)

Pump Launcher Velocities, fps							Pivot Launcher Velocities, fps						
	Avg IV 20 Feet from			Variations				Avg IV 20 Feet from			Variations		
Launcher No.	Muzzle	Max	Min	Mean	Extreme	Std Dev	Launcher No.	Muzzle	Max	Min	Mean	Extreme	Std Dev
Round Nos. 391 to 400.													
AA14	244.3	248.6	241.3	2.2	7.3	2.6	AN2	234.6	237.4	230.7	1.8	6.7	2.3
AA15	244.9	247.9	238.1	1.7	9.8	2.7	AN3	237.0	243.0	231.2	2.9	11.8	3.7
AA16	244.4	246.8	242.0	1.2	4.8	1.6	AN8	232.8	236.6	222.4	2.5	14.2	4.0
Avg	244.5			1.7	7.3	2.3	Avg	234.8			2.4	10.9	3.3
Round Nos. 401 to 500.													
AA14	242.7	247.0	238.2	2.1	8.8	2.6	AN2	234.0	238.2	229.7	1.8	8.5	8.5
AA15	241.4	244.9	238.8	1.7	6.1	2.0	AN3	233.5	238.8	227.9	2.6	10.9	10.9
AA16	243.1	245.9	240.0	1.6	5.9	2.0	AN8	232.5	233.6	231.0	1.0	2.6	2.6
Avg	242.4			1.8	6.9	2.2	Avg	233.4			1.8	7.3	2.3
Round Nos. 590 to 600.													
AA14	244.8	249.7	239.4	2.2	10.3	2.9	AN2	237.0	239.7	233.2	1.8	6.5	2.1
AA15	244.6	247.5	242.7	1.1	4.8	1.5	AN3	237.1	241.3	230.8	2.3	10.5	3.2
AA16	246.0	247.6	243.0	1.5	4.6	1.8	AN8	235.4	239.3	231.0	2.0	8.7	2.6
Avg	245.1			1.6	6.6	2.0	Avg	235.4			2.0	8.6	2.7
Round Nos. 601 to 610.													
AA14	242.7	247.1	238.4	2.5	8.7	2.9	AN2	233.8	237.5	227.8	1.9	9.7	2.7
AA15	241.8	243.8	236.3	1.4	7.5	2.1	AN3	229.8	235.8	221.4	3.7	14.4	4.8
AA16	242.4	246.0	239.3	1.2	6.7	1.8	AN8	232.9	237.1	230.1	1.9	7.0	2.4
Avg	242.3	245.6	238.0	1.7	7.6	2.3	Avg	232.9			2.5	10.4	3.3

Table 2.13-V (Cont'd)

Pump Launcher Velocities, fps							Pivot Launcher Velocities, fps						
	Avg IV 20 Feet from			Variations				Avg IV 20 Feet from			Variations		
Launcher No.	Muzzle	Max	Min	Mean	Extreme	Std Dev	Launcher No.	Muzzle	Max	Min	Mean	Extreme	Std Dev
Round Nos. 791 to 800.													
AA14	243.3	247.9	237.9	3.3	10.0	3.8	AN2	233.6	238.7	229.1	2.2	9.6	2.8
AA15	240.5	243.6	229.9	2.5	13.7	4.0	AN3	231.7	234.8	224.6	2.4	10.2	3.1
AA16	244.4	246.1	242.9	1.2	3.2	1.3	AN8	235.3	241.8	230.4	2.6	11.4	3.5
Avg	242.7	245.9	236.9	2.3	9.0	3.0	Avg	233.5			2.4	10.4	3.2
Round Nos. 801 to 810.													
AA14	241.8	243.9	236.2	1.6	7.7	2.3	AN2	231.5	238.4	221.3	3.9	17.1	5.1
AA15	242.4	247.2	239.8	1.5	7.4	2.1	AN3	232.0	235.8	226.0	2.5	9.8	3.2
AA16	241.0	244.4	237.2	1.8	7.2	2.3	AN8	232.2	237.8	228.5	2.4	9.3	3.0
Avg	241.7			1.6	7.4	2.3	Avg	232.2			2.9	12.1	3.8
Round Nos. 991 to 1000.													
AA14	243.1	246.7	237.7	2.8	9.0	3.3	AN2	234.0	236.6	231.9	1.3	4.7	1.6
AA15	241.9	244.9	238.5	1.8	6.4	2.2	AN3	236.1	239.6	231.4	1.8	8.2	2.4
AA16	242.1	244.7	238.6	2.0	6.1	2.3	AN8	232.2	238.1	226.6	3.8	11.5	4.5
Avg	242.4			2.2	7.2	2.6	Avg	234.1			2.3	8.1	2.8

Table 2.13-VI (U). Velocity Data Recorded at End of the Reliability Test with the DBCATA Launcher[a] (U)

Launcher No.	Launcher Velocities, fps[b] Avg IV 20 Feet from Muzzle	Max	Min	Variations Mean	Extreme	Std Dev
Cartridge: 40-mm, DBCATA, M407A1, lot 51303-1017.						
DB14	252.9	258.5	248.9	2.3	9.6	2.8
DB15	251.1	254.3	247.5	1.6	6.8	2.0
DB16	250.9	255.6	248.1	1.4	7.5	1.8
Avg	251.6			1.7	8.0	2.2

[a]Since the DBCATA launcher is only a launching platform for the disposable-barrel cartridge, velocity measurements were not recorded throughout the test as each round has a new barrel and the velocity data were mainly to determine velocity loss resulting from barrel wear.

[b]All data are an average of 20 rounds.

The stoppage rates per 100 rounds fired for the three pump launchers throughout 1000 rounds of firing were 3.8, 0.5, and 0.6; similarly, for the pivot launchers, the rates were 13.2, 11.3, and 22.3, and those for the DBCATA were 2.8, 3.8, and 1.1.

No detrimental effects from the partial primer punchouts were observed with either the pump or pivot launcher. Inspection of firing pin contour, diameter, and protrusion failed to reveal any conclusive cause for the partial punchouts.

After-test inspection of the pump launchers showed that some deformation and errosion had occurred around the firing-pin hole. This condition was attributed to the flowback of the primer around the firing pin tip. The design of the pump launcher was such that the firing pin remained in the forward position after firing with the tip protruding through the breech until the gunner reloaded the launcher. No detrimental effects on launcher performance was noted from this condition.

As in other subtests, the mounting bracket screws on the pump launchers bent and deformed in the area where the head joins the body of the screw. At the start of the reliability test (Table 2.13-I) the mounting bracket screws which were in the launchers as initially received were replaced with longer screws by the Code AA representative. This did not eliminate the problem. None of the screws broke but the bending and deformation hindered the removal and attachment of the launcher to the rifle, and undoubtedly aggravated the breaking and chipping of barrel insulators, as the bending and deformation of the mounting screws loosened the mounting bracket.

The firing of the DBCATA launchers while held loosely in the hands and at various attitude positions as described in the methods paragraph was accomplished during the last 200-round cycle of the reliability test (Table 2.13-III). No problems or malfunctions occurred which were attributatle to the various hand-held positions.

Broken or unserviceable parts were experienced with all three launcher types during the reliability test. The pump launcher experienced broken and chipped barrel bracket insulators, the safety could not be actuated on one launcher due to use, the handgrip on one launcher had to be reglued, and the replacement of extractor springs was required. The pivot launchers demonstrated excessive wear on the sides of the barrel-lock slot which caused failures to fire. Also, the flexible leaf spring in the primary sight developed cracks around the retaining rivet which allowed the spring to lose tension.

The DBCATA launcher was modified with the addition of a firing-pin-stop in an attempt to correct the failure-to-sear malfunction and then an inadvertent fire occurred which was directly associated with the modification. Consequently, a stronger primary sear spring was installed. Also, the positioning-stud on one launcher sight sheared and as with the pump launchers the barrel-bracket insulators broke and chipped.

The velocity performance data recorded with the pump and pivot launchers during the reliability test showed no degradation from the firing of over 1000 rounds. The bore measurements before and after test for the reliability-test launchers are contained in Appendix I.

The group dispersion data presented in Table 2.13-VII show that dispersion performance of the launchers was not degraded by the extended firings of the reliability test. The shifts in center-of-impact between groups fired at different stages during the reliability test were attributed to inadequacies of the sights on all three systems. The sights on the pump and DBCATA continually came loose during test and the sight on the DBCATA launcher shifted in range setting with the recoil of the launcher. The sight on the pivot launcher shifted in range setting and also the leaf spring which holds the front sight post lost tension, with the result that the front sight would fail to return to position after a round was fired.

Table 2.13-VII (U). Launcher Dispersion Data Obtained During the Reliability Test (U)[a]

Launcher Identification	Previous Rds Fired[b]	Center of Impact Location Hor	Center of Impact Location Vert	Mean Radius	Deviations Hor Mean	Deviations Hor Std	Deviations Vert Mean	Deviations Vert Std	Extremes Hor Disp	Extremes Vert Disp	Extremes Spread
Pump 14	0	+ 1.1	+ 4.4	4.2	1.8	2.3	3.5	4.4	7.2	12.6	13.6
	500	+ 0.8	+12.4	4.3	2.0	2.4	3.4	4.7	7.4	16.3	17.1
	1000	+ 6.0	+20.9	4.8	2.3	3.1	3.6	4.9	10.4	16.1	16.4
Pump 15	0	- 5.7	0.0	4.3	1.5	2.0	3.6	5.0	7.0	16.9	17.0
	500	- 2.6	+ 5.8	4.0	1.7	2.0	3.3	4.3	6.1	14.0	14.5
	1000	+10.1	+12.7	4.5	2.0	2.6	3.5	4.5	7.5	14.4	14.5
Pump 16	0	- 2.4	- 5.3	4.8	2.0	2.5	3.9	4.9	7.6	15.5	15.6
	500	- 2.0	+ 1.4	6.6	1.7	2.2	6.0	8.2	6.9	28.7	28.8
	1000	- 2.7	+ 9.4	4.6	2.1	2.8	3.7	4.8	9.4	15.5	15.8
Pivot 02	0	- 8.5	+ 3.6	4.1	2.7	3.6	2.3	3.1	11.5	9.8	14.1
	[c] 500	-40.4	-33.0	4.5	3.5	4.3	2.3	3.1	13.5	10.2	14.0
	1000	- 2.6	+ 9.9	5.9	4.0	5.3	3.6	4.9	17.0	16.5	21.4
Pivot 03	0	- 1.8	- 1.6	4.1	2.0	2.6	3.2	4.4	8.8	14.5	15.1
	500	+ 7.1	-24.8	3.3	1.8	2.3	2.3	3.2	7.4	11.1	12.4
	1000	-17.5	- 9.6	3.5	1.7	2.4	2.5	3.3	8.2	10.7	12.5
Pivot 08	0	- 1.0	+19.4	4.2	1.9	2.2	3.6	4.3	6.2	13.6	14.5
	500	+10.7	-15.2	8.0	1.9	2.6	7.4	9.2	8.7	27.5	27.7
	1000	+ 5.2	- 9.7	3.4	1.8	2.3	2.6	3.3	7.6	9.7	11.3
DBCATA 14	0	+ 7.6	+ 4.0	7.2	4.1	5.4	5.3	6.5	17.7	20.3	24.0
	500	+ 4.7	- 3.0	5.8	3.5	4.6	3.9	5.3	14.8	18.2	19.7
	1000	+ 4.4	- 1.2	6.5	3.7	4.6	4.6	6.5	14.7	22.6	24.2

[a]All target measurements are in inches and are an average of three 10-round groups at 50-meters range against a vertical target.
[b]The zero is used as a symbol to indicate the beginning of the test as all launchers had been fired 20 to 30 rounds for function and velocity measurements prior to the start of the reliability test.
[c]The accuracy firings at the 500- and 1000-round stages were fired with the sight from pivot launcher No. 12, as the flexible leaf spring in the primary sight had failed. See footnote b in Table 2.13-II.

Table 2.13-VII (Cont'd)

Launcher Identification	Previous Rds Fired[b]	Center of Impact Location		Mean Radius	Deviations				Extremes		
		Hor	Vert		Hor		Vert		Hor	Vert	
					Mean	Std	Mean	Std	Disp	Disp	Spread
DBCATA 15	0	- 0.2	- 0.5	6.6	2.9	3.5	5.0	7.4	10.9	25.3	26.0
	500	- 6.1	+ 9.9	9.0	3.1	4.0	7.8	9.4	12.7	25.9	26.1
	1000	- 2.2	+ 9.9	7.8	2.4	3.4	7.1	8.4	11.8	24.3	24.9
DBCATA 16	0	0.0	+ 5.2	5.1	3.0	4.0	3.4	4.5	13.0	15.1	17.5
	500	- 0.8	+ 5.2	4.5	2.6	3.7	3.0	3.9	13.1	12.5	14.7
	1000	+ 0.7	- 1.0	5.8	2.5	3.1	4.8	6.2	9.9	19.2	20.1

[b]The zero is used as a symbol to indicate the beginning of the test as all launchers had been fired 20 to 30 rounds for function and velocity measurements prior to the start of the reliability test.

The shift in center-of-impact of the groups fired with the M16A1 rifles (Table 2.13-VIII) were statistically analyzed. The results are given in Table 2.13-X.

Table 2.13-VIII (U). Rifle Accuracy Data Obtained During the Reliability Test of the Launcher (100 Meters) (U)

Weapon Identification	Center of Impact Location[a] Before Test Hor	Before Test Vert	After 500 Rds Hor	After 500 Rds Vert	After 1000 Rds Hor	After 1000 Rds Vert
Cartridge: 5.56-mm, ball, M193, lot TW-18249.						
Pump 14	-0.5	+3.2	-3.2	+0.8	-0.5	+1.9
Pump 15	-0.2	+2.3	-1.1	+0.1	-1.3	-0.2
Pump 16	-1.8	+0.8	-1.3	-1.0	-2.4	-1.9
Pivot 02	+0.2	+5.1	+1.2	+0.2	+0.8	+0.3
Pivot 03	+0.2	+3.2	-0.7	+1.9	-1.0	+3.8
Pivot 08	-0.2	+2.8	+0.1	-4.3	+2.1	-3.6
DBCATA 14	-0.2	+2.7	+3.1	+0.2	+1.5	-1.5
DBCATA 15	-0.1	+6.1	+4.1	+1.4	+0.3	+1.9
DBCATA 16	0.0	+4.2	-2.4	+0.4	-2.2	+0.7

[a]The center-of-impact locations are an average of three 10-round groups and are in inches relative to the aiming point.

Table 2.13-IX (U). Statistical Analysis of Group Center-of-Impact Shifts with the M16A1 Rifle (U)

Legend: S = Statistically significant differences (95% confidence).
NS = Statistically nonsignificant difference.

Rifle Serial No.	Attached Launcher	Rounds Fired 0 to 500	Rounds Fired 500 to 1000
805412	Pump 14	S	NS
803820	Pump 15	S	NS
807688	Pump 16	NS	NS
812573	Pivot 02	S	NS
722159	Pivot 03	NS	NS
812895	Pivot 08	S	S
808430	DBCATA 14	S	NS
808191	DBCATA 15	S	S
809325	DBCATA 16	S	NS

2.13.5 Analysis (U)

(C) None of the launchers met the requirements of the technical characteristics that the launcher be capable of firing at least 1000 rounds without incurring broken or unserviceable parts.

(U) Other than the rifle failures to fire and failures-to-remain seared, which were induced due to launcher recoil, the function performance of the M16A1 rifle (Table 2.13-X) was not degraded with the attachment of the launcher. However, the significance of the induced malfunctions must not be under rated. The failures to fire were due to the bolt group in the M16A1 rifle moving rearward with the firing of the attached launcher and sometimes failing to return to the locked position. Since the rifle will not fire when this occurs, without remedial action, the rifle must be considered rendered temporarily inoperative by the action of firing the launcher. Obviously, this is undesirable and must be assessed from the viewpoint as to whether training of the user can accommodate this condition or is a mechanical solution required. From the engineering viewpoint this was classified as a shortcoming to the system.

Table 2.13-X (U). M16A1 Rifle Function Data Obtained During the Launcher Reliability Test (U)[a]

Rifle Serial No.	Attached Launcher	No. Rds Fired	Malfunctions	Remarks
Ammunition: Cartridge, 5.56-mm, M196, lot TW18249.				
805412	Pump 14	1900	0	
803820	Pump 15	1900	0	
807688	Pump 16	1900	0	
812573	Pivot 02	1960	0	
722159	Pivot 03	1980	2-FJ 3-FTR 2-F2R	The hammer pin moved out of position two times. The first time 3-FTR occurred, and approximately 600 rounds later on the second occassion two incidents of firing 2 rounds occurred.

Table 2.13-X (Cont'd)

Rifle Serial No.	Attached Launcher	No. Rds Fired	Mal-functions	Remarks
812895	Pivot 08	1980	0	
808430	DBCATA 14	2040	1-FBR	
808191	DBCATA 15	2040	2-FBR	
809325	DBCATA 16	2040	1-BOB	
			1-FF	The nose of the last round from the magazine stubbed on the rear of the barrel extension.

[a]This table does not contain the failure-to-fire and failure-to-remain-seared malfunctions which were induced due to the firing of the launcher. These types of malfunctions are recorded in the tables with launcher performance data.

(U) The occurrence of failures of the rifle to remain seared, which also occurred with the recoil of the attached launcher and required recharging of the rifle, must be classified as a safety hazard. Normally, the rifle does not fire since the bolt-carrier group is moved rearward with the recoil; however, in two instances inadvertent firing of the rifle with the firing of an attached launcher did occur (paragraph 2.6). On this basis, the failure to remain seared of the rifle with launcher recoil must be classified as a deficiency.

(U) The change in group location which occurred with the M16A1 rifle between the data obtained before test and after 500-rounds had been fired from the attached launchers and that between the 500-round stage and the 1000-round stage indicated that the use of the attached launcher was detrimental to the accuracy of the M16A1 rifle. The change in group location between the before-test and the 500-round stage with all rifles irrespective of launcher attached, was in a downward direction and the changes in group location between the 500-round stage and the 1000-round stage was a random shift. The shift with 7 of the 9 rifles was significant between the before-test and the 500-round stage and was significant with 2 of the 9 rifles between the 500-round stage and the 1000-round stage (reference Table 2.13-IX).

(U) At this time it should be noted that similar shifts in group location occurred with the firing of an M16A1 rifle without a launcher attached in the barrel-durability test (paragraph 2.14). In this test, an M16A1 rifle was fired in cycles of 100, 200, and 300 rounds with accuracy firing between cycles. The shift in group location (Table 2.14-II) was just as large with the M16A1 rifle in this test as that which occurred with rifles during the launcher reliability test.

2.14 (U) RIFLE BARREL DURABILITY TEST

2.14.1 Objective

The objective is to determine if permanent bending of the M16A1 rifle barrel would result with the firing of an attached grenade launcher with the rifle barrel hot from firing. This subtest was conducted upon request of the Project Managers, AMCPM-RS (Reference 4).

2.14.2 Criteria

The firing of an attached grenade launcher shall not cause bending of the rifle barrel such that permanent deformation is induced.

2.14.3 Method

One launcher of each type was attached to an M16A1 rifle and tested as follows:

a. The barrels on the rifles were gaged for straightness.

b. The rifles were zeroed at a range of 100 meters by an expert rifleman and five 10-round groups were fired with each rifle.

c. Each rifle then was fired 100 rounds in the automatic mode as rapidly as possible. The firing was accomplished from a shoulder-held position and the firing time was recorded. Immediately upon completion of firing the rifle, the attached launcher was fired 10 rounds from a shoulder-held position. The rifle was then allowed to cool and three 10-round groups were fired at 100 meters using the same rifleman as employed in paragraph b.

d. The procedures of paragraph c were repeated twice firing increments of 200 and 300 rounds from the rifle.

For control purposes an M16A1 rifle without a launcher attached was fired employing the same methods and firing cycles as with a launcher attached.

2.14.4 Results

A shift in center of impact resulted with all weapons from cycle to cycle. However, gaging of the rifle barrels for straightness after the exercise disclosed that no permanent bending had resulted from the rapid firing of the rifles or firing of the attached launchers with the rifle barrel hot. The recorded firing times for the increments of 100, 200, and 300 rounds are given in Table 2.14-I. The location of the centers-of-impact of the 100-meter accuracy groups fired prior to the test and after each successive cycle are given in Table 2.14-II.

Table 2.14-I (U). Recorded Firing Time, seconds (U)

No. of Rds Fired	Weapon			
	M16 Pump	M16 Pivot	M16 DBCATA	M16
100	20	21	21	19
200	47	43	49	[a]58
300	68	62	74	62

[a]The occurrence of a stoppage lengthened the firing-time.

Table 2.14-II (U). Center-of-Impact Data (U)

Test Cycle	Center of Impact Location Aiming Point, in. Hor	Vert
Weapon: M16A1 rifle with pump launcher attached.		
Before test	0.0	+4.0
After 100 rounds	+1.2	-1.6
After 200 rounds	-0.9	-2.8
After 300 rounds	+1.8	+4.9
Weapon: M16A1 rifle with pivot launcher attached.		
Before test	+1.5	+2.3
After 100 rounds	+2.6	+3.2
After 200 rounds	+1.3	+6.9
After 300 rounds	+0.8	+8.4

Table 2.14-II (Cont'd)

Test Cycle	Center of Impact Location Aiming Point, in. Hor	Vert
Weapon: M16A1 rifle with DBCATA launcher attached.		
Before test	+1.7	+4.7
After 100 rounds	+1.0	+0.7
After 200 rounds	+1.7	-3.7
After 300 rounds	+4.6	-3.1
Weapon: M16A1 rifle without launcher.		
Before test	+1.5	+3.3
After 100 rounds	-1.8	-2.7
After 200 rounds	-0.9	+3.0
After 300 rounds	+1.1	-3.1

2.14.5 Analysis

Comparison of accuracy performance of the rifle with and without, a launcher attached, and barrel-straightness gagings before and after test, demonstrated that no permanent deformation of the rifle barrel occurs with firing of the launcher when the rifle barrel is hot.

2.15 RUGGEDNESS TEST (U)

2.15.1 (U) Objective

The objective is to determine the ability of the test launchers and sights to withstand being dropped on hard-packed earth.

2.15.2 (C) Criteria (U)

Criteria are as follow:

a. The sighting system for the launcher, when attached to the weapon - launcher combination, shall withstand the impact of dropping the weapon butt-downward from a height of three feet on hard-packed earth. The sights and mountings shall remain in serviceable condition after three such drops, so that the range and deflection obtained in firing correspond correctly to the respective range and deflection settings which are applied to the sight.

b. The unloaded launcher, when attached to the point-fire weapon, shall withstand dropping on hard-packed earth from a height of three feet, so that the weapon - launcher combination impacts muzzle downward, or butt downward, or on either side, or on the top or bottom. After one drop in each of these six positions, the launcher shall be capable of being safely fired.

2.15.3 (U) Method

One pump and one pivot launcher were assembled to M16A1 rifles and dropped butt downward from a three-foot height on hard-packed earth. Prior to being dropped each launcher sight was adjusted to the 100-meter range and a 10-round group fired. After the final drop, the range setting was checked and reset if necessary and a second 10-round group was fired. The DBCATA launcher was not subjected to this phase of the ruggedness test as the design of the sight and the means of attachment was the same as that for the pump launcher.

The same two weapons and a DBCATA mounted on an M16A1 rifle were dropped on hard-packed earth from a height of three feet, to impact muzzle downward, butt downward, on either side, on the top, and on the bottom. After each of the drops (six total), the launchers were fired three rounds.

2.15.4 (U) Results

The sights and mountings withstood the impact of dropping the weapon butt-downward and no change in group center-of-impact resulted between the before- and after-test firings at 100 meters. However, the sight on the pivot launcher did shift in range setting and had to be reset prior to accuracy firing.

In the second phase of the ruggedness test, all of the launchers were capable of being safely fired after each of the drops. The sights on both the pump and DBCATA became bent and damaged to the extent of being unserviceable when the weapon was dropped on the left side. The primary sight on the pivot launcher changed range setting, but was still serviceable.

2.15.5 (C) Analysis

The sight system and mountings of all launchers met the requirements of the technical characteristics with respect to withstanding the impact incident with dropping of the weapon butt-downward from a 3-foot height onto hard-packed earth. Only the sight on the pivot launcher withstood being dropped in an orientation that permitted the sight to strike the gouund.

2.16 (U) SOLVENTS AND LUBRICANTS COMPABIBILITY

2.16.1 Objective

The objective was to determine the chemical compatibility of the test launchers with various chemical compounds used as cleaners, lubricants, and insecticides.

2.16.2 Criteria

The durability and functional operation of the test launchers must not be degraded by reaction of the design material to various chemicals.

2.16.3 Method

All launchers to be tested were cleaned and no lubricant was applied. One launcher of each model was then immersed into one of the chemicals listed below for a 10-minute period on each of four days and stored at ambient temperature. Inspection of each launcher, particularly components made of rubber, plastic, or synthetic materials, were made prior to each day's immersion. The following chemicals were used:

a. Bore cleaner (MIL-L-372-B).

b. VV-L-800 lubricant.

c. Gasoline.

d. Kersoene.

e. Diesel fuel.

f. JP-4 jet fuel.

g. Insect repellent (FSN 6840-558-0918).

h. MIL-L-14107 lubricant.

Note: PS-661-B cleaning solvent and MIL-L-46000A lubricant were not included inasmuch as the launchers were subjected to these chemicals throughout the test.

2.16.4 Results

With the exception of insect repellent, none of the chemicals had any detrimental effects on the launchers. The insect repellent dissolved the compound used to glue the handgrip on the barrel of the pump launcher. At the end of the test the handguard was not loose, but the compound had seeped from both ends; therefore, it would only be a matter of time until the handguard came loose.

To further assure that insect repellent would dissolve the compound used on the pump launchers, an area approximately two inches in diameter on a piece of steel was covered with the compound and allowed to set up. Insect repellent was then applied with the result that the compound was liquified in approximately 30 minutes.

2.16.5 Analysis

The detrimental effects of the insect repellent on the compound used with the handgrip on the pump launcher was classified as a shortcoming of the weapon.

SECTION 3. (U) APPENDICES

APPENDIX I - TEST DATA

Table I-I (U). Firing Pin Measurements for the Pump Launchers[a] (U)

Launcher No.	Weight, grains	Tip Radius, in.	Body Diameter, in.	Distance From Forward Shoulder to Tip, in.
8	314	0.076	0.4915	0.3726
9	313	.076	.4913	.3722
10	313	.074	.4911	.3724
11	315	.074	.4909	.3742
12	315	.078	.4915	.3727
13	313	.076	.4912	.3717
14	313	.080	.4911	.3707
15	312	.076	.4912	.3760
16	313	.076	.4913	.3754
17	314	.080	.4911	.3712
18	314	.078	.4909	.3730
20	312	.078	.4911	.3736

[a]The firing pin is shown in Figure 2.2-1, Part No. 30.

Table I-II (U). Firing Pin Measurements for the Pivot Launcher[a] (U)

Launcher No.	Weight, grains	Tip Radius, in.	Body Diameter, in.
02	34	0.046	0.0932
03	33	.046	.0930
04	33	.046	.0929
05	33	.044	.0933
06	33	.044	.0930
07	33	.044	.0935
08	33	.046	.0935
09	33	.046	.0937
10	32	.044	.0900
11	33	.044	.0940
12	33	.042	.0885
13	32	.042	.0883

[a]The firing pin is shown in Figure 2.2-2, Part 21.

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Field	Entry
40 M/M Grenade Launcher	
Number	8
Manufacturer	AA
Casting Number	X
Model	
Date of Gauging	1 May 68
Firing Status (Check One)	Before ✓ / After
Number of Rounds	BF APG
Proof Officer	Mr. Keele W.O. 324-329-80

Grenade Launcher

Distance (inches) from Muzzle Face	Gage measurements indicated in 1/1000" — Lands 1.573 Zero — Vert.	Lands — Hor.	Grooves 1.573 Zero — Vert.	Grooves — Hor.
.10	+.041	+.040	+.059	+.056
.50	38	36	57	56
.75	38	36	56	54
1.00	38	36	56	53
2.00	38	36	55	53
3.00	37	36	55	53
4.00	37	36	54	54
5.00	37	36	54	54
6.00	37	36	54	54
7.00	37	36	54	54
8.00	37	36	54	54
9.00	37	36	54	54
9.50	37	36	54	54
10.00	+0.37	+.036	+.0 54	+.054
	Chamber Section (Actual Diam.) — Y	X		
10.25	1.631	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"

No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged By

Keene

Morris

Martins

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER: X

MANUFACTURER: AA

PROOF OFFICER MR. KEELE W.O. 324-329-80

MODEL:

NUMBER OF ROUNDS: BF - APG

NUMBER: 9

FIRING STATUS (Check One): BEFORE ✓ AFTER

DATE OF GAUGING: 3 MAY 1968

10 M/M Grenade Launcher

Distance (inches) from Muzzle Face	Gage measurements Indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.053	+.053
.50	36	36	53	53
.75	36	36	54	53
1.00	36	36	54	53
2.00	36	36	53	53
3.00	36	36	53	53
4.00	36	36	53	53
5.00	36	36	53	53
6.00	36	36	53	54
7.00	36	36	53	54
8.00	36	36	53	54
9.00	36	36	53	54
9.50	36	36	53	54
10.00	+.036	+.037	+.053	+.054
	Chamber Section (Actual Diam.)			
	Y	X		
10.25	1.632	1.632		
11.00	1.632	1.632		
11.50	1.632	1.632		
11.85	1.632	1.632		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"

No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AA
PROOF OFFICER	ME. REEE W.O. 52+-329-80
MODEL	
NUMBER OF ROUNDS	87 AG
NUMBER	10
FIRING STATUS (Check One) BEFORE	✓
FIRING STATUS (Check One) AFTER	
DATE OF GAUGING	May 68
	40 M/M Grenade Launcher

Distance (inches) from Muzzle Face	Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.037	+.037	+.053	+.053
.50	37	37	53	53
.75	36	37	53	53
1.00	36	37	53	53
2.00	36	37	53	53
3.00	36	36	53	53
4.00	37	36	53	53
5.00	37	36	53	53
6.00	37	37	53	54
7.00	37	37	54	54
8.00	37	37	54	54
9.00	37	37	54	54
9.50	37	37	54	54
10.00	+.037	+.037	+.054	+.054
	Chamber Section (Actual Diam.)			
	X	X		
10.25	1.631	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gage #6
Reade
Mabry
Martin

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	A.A.
PROOF OFFICER MR KEELE W.O. 324-329-80	
MODEL	
NUMBER OF ROUNDS FIRED BEFORE	
NUMBER	11
FIRING STATUS (Check One) AFTER	
BEFORE	X
DATE OF GAUGING	1 May 68
	40 M/M Grenade Launcher

Distance (Inches) from Muzzle Face	Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.037	+.038	+.053	+.053
.50	37	37	53	53
.75	37	37	53	53
1.00	37	37	53	53
2.00	37	37	53	53
3.00	37	36	53	53
4.00	36	36	53	53
5.00	36	36	53	53
6.00	36	36	53	53
7.00	36	36	53	53
8.00	36	36	53	53
9.00	35	36	53	53
9.50	35	36	53	53
10.00	+.035	+.036	+.053	+.053
	Chamber Section (Actual Diam.)			
	Y	I		
10.25	1.632	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.632	1.632		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru out chamber and bore.

Gaged by:
Insp.
Insp.
Mich.

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	MANUFACTURER	PROOF OFFICER	NUMBER OF ROUNDS	FIRING STATUS (Check One)	DATE OF GAGING
	AA	MR. WEELE W.O. 324-329-80	BF - APG	BEFORE ✓ / AFTER	1968

MODEL	NUMBER
M X/M Grenade Launcher	12

Distance (inches) from Muzzle Face	Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.037	+.037	+.054	+.054
.50	37	37	54	54
.75	36	37	54	54
1.00	36	37	53	54
2.00	36	37	53	54
3.00	36	37	53	53
4.00	36	36	54	53
5.00	36	36	54	53
6.00	36	36	54	53
7.00	36	36	54	53
8.00	36	36	54	53
9.00	36	36	54	53
9.50	36	36	54	53
10.00	+.036	+.036	+.054	+.053
	Chamber Section (Actual Diam.)			
	Y	X		
10.25	1.631	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several light longitudinal scratches scattered thru-out chamber and bore. Very light metallic deposits and other deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER: X

MANUFACTURER: AA

PROOF OFFICER N.E. WEELE (W.O.) 324-329-80

MODEL:

NUMBER OF ROUNDS: BF - APG

NUMBER: 13

FIRING STATUS (Check One): ✓ BEFORE / AFTER

DATE OF GAUGING: 8 MAY 1968

40 M/M Grenade Launcher

Distance (inches) from Muzzle Face	Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.037	+.053	+.053
.50	36	37	53	53
.75	36	37	53	53
1.00	36	37	53	53
2.00	36	37	53	53
3.00	36	37	53	53
4.00	36	37	53	53
5.00	36	37	53	53
6.00	36	36	53	53
7.00	36	36	53	53
8.00	36	36	53	53
9.00	36	36	53	53
9.50	36	36	53	53
10.00	+.036	+.036	+.053	+.053
	Chamber Section (Actual Diam.) Y	X		
10.25	1.631	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"

No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER: X

MANUFACTURER: AA

PROOF OFFICER: Mr. KEELE W.O. 324-329-80

MODEL:

NUMBER OF ROUNDS: BF - APG

NUMBER: 14

FIRING STATUS (Check One): BEFORE ✓ AFTER

40 M/M Grenade Launcher

DATE OF GAUGING: 3 MAY 1968

Distance (inches) from Muzzle Face	Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.053	+.053
.50	36	36	53	53
.75	36	36	53	53
1.00	36	36	53	53
2.00	36	36	53	53
3.00	36	36	53	53
4.00	35	36	53	53
5.00	35	36	53	53
6.00	35	36	53	53
7.00	35	36	53	53
8.00	35	36	53	53
9.00	35	36	53	53
9.50	35	36	53	53
10.00	+.035	+.036	+.053	+.053
	Chamber Section (Actual Diam.)			
	Y	X		
10.25	1.631	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

40 M/M Grenade Launcher

CASTING NUMBER	MANUFACTURER	MODEL	NUMBER	DATE OF GAUGING
X	AA		AA 14	5 August 1968

PROOF OFFICER: MR. Keele W.O. 324-329-80

NUMBER OF ROUNDS: 1040

FIRING STATUS (Check One): BEFORE / AFTER ✓

Grenade Launcher

Distance (Inches) from Muzzle Face	Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
	Gage measurements indicated in 1/1000"			
.10	+.037	+.036	+.054	+.054
.50	37	36	54	54
.75	37	36	54	54
1.00	37	36	54	54
2.00	37	36	54	54
3.00	37	36	54	54
4.00	37	36	54	54
5.00	37	36	54	54
6.00	38	37	54	54
7.00	38	37	54	54
8.00	38	37	54	54
9.00	38	38	54	54
9.50	38	38	54	54
10.00	+.038	+.038	+.054	+.054

Chamber Section (Actual Diam.)

Distance	Y	X
10.25	1.632	1.631
11.00	1.631	1.631
11.50	1.631	1.631
11.85	1.631	1.631

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"

No. of lands - 6

Remarks: (Borescoped):
Several very light longitudinal scratches with very light metallic [illegible] deposits [illegible] out chamber [illegible].

Gaged by Koope Cox [illegible]

3

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	.
MANUFACTURER	AA
PROOF OFFICER	MR. MEEKS (W.C.) 324-329-80
MODEL	
NUMBER OF ROUNDS	BF - APG
NUMBER	15
FIRING STATUS (Circle One)	BEFORE / AFTER
DATE OF GAUGING	5 MAY 1968
	40 M/M Grenade Launcher

Distance (Inches) From Muzzle Face	Gage Measurements Thousandths of 1/1000" Lands 1.573 Zero Vert.	Hor.	Grooves 1.573 Zero Vert.	Hor.
.10	+.036	+.036	+.053	+.053
.50	36	35	53	53
.75	36	35	53	53
1.00	36	35	53	53
2.00	36	35	53	53
3.00	36	35	53	53
4.00	36	36	54	53
5.00	36	35	54	53
6.00	36	36	54	53
7.00	36	36	54	53
8.00	36	36	54	53
9.00	36	36	54	53
9.50	36	36	54	53
10.00	+.036	+.036	+.054	+.053
	Chamber Section (Actual Diam.) X	Y		
10.25	1.631	1.631		
11.00	1.631	1.631		
11.50	1.631	1.631		
11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

STEAP-DS Form 106. 17 Jun 64 (Part I)

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

- **Model:** 40 M/M Grenade Launcher
- **Number:** AA 15
- **Manufacturer:** AA
- **Casting Number:** X
- **Proof Officer:** Mr. Reele W.O 324-329-80
- **Number of Rounds:** 1040
- **Firing Status (Check One):** Before / After ✓
- **Date of Gauging:** 8 August 1968

Grenade Launcher

Distance (Inches) from		Muzzle Face	Gage Measurements [illegible] in 1/1000" Lands 1.573 Zero Vert.	Lands Hor.	Grooves 1.573 Zero Vert.	Grooves Hor.
		.10	+.038	+.037	+.055	+.054
		.50	36	37	55	54
		.75	36	37	55	54
		1.00	36	37	55	54
		2.00	36	37	55	54
		3.00	36	37	54	54
		4.00	36	37	54	54
		5.00	36	37	54	54
		6.00	36	37	54	54
		7.00	37	37	54	54
		8.00	37	37	54	54
		9.00	37	37	54	54
		9.50	37	37	54	54
		10.00	+.037	+.037	+.054	+.054
			Chamber Section (Actual Diam.) Y	X		
		10.25	1.631	1.631		
		11.00	1.631	1.631		
		11.50	1.631	1.631		
		11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"

No. of lands - 6

Remarks: (Borescoped):
Several very light longitudinal scratches with very light metallic and other deposits throughout chamber and bore.

Gaged by
Roope
Cox
Barker

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER:

MANUFACTURER: AA

PROOF OFFICER: MC. NEELE W.O. 324-320-80

MODEL:

NUMBER OF ROUNDS: 6F-APG

NUMBER: 16

FIRING STATUS (Check One): BEFORE ✓ AFTER

DATE OF GAUGING: MAY 1968

40 M/M Grenade Launcher

Distance (Inches) From Muzzle Face	Gage measurements Indicate in 1/1000" — Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.033	+.038	+.054	+.056
.50	36	37	54	55
.75	35	37	53	54
1.00	35	37	53	54
2.00	36	37	53	53
3.00	36	37	53	53
4.00	36	37	53	53
5.00	36	37	53	53
6.00	36	37	53	53
7.00	36	37	53	53
8.00	36	36	53	53
9.00	36	36	53	53
9.50	36	36	53	53
10.00	+.036	+.036	+.053	+.053
	Chamber Section (Actual Diam.)			
	Y	X		
10.25	1.632	1.632		
11.00	1.632	1.632		
11.50	1.631	1.632		
11.85	1.632	1.632		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic deposits and other deposits thru-out chamber and bore.

Gaged by: Roone
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

40 M/M Grenade Launcher			
DATE OF GAUGING	8 August 1968		
NUMBER	AA 16	FIRING STATUS (Check One)	AFTER ✓ / BEFORE
MODEL		NUMBER OF ROUNDS	1040
MANUFACTURER	AA	PROOF OFFICER	Mr. Keele W.O. 324-329-80
CASTING NUMBER	X		

Grenade Launcher

Distance (Inches) from			Gage measurements indicated in 1/1000"			
		Muzzle Face	Lands 1.573 Zero		Grooves 1.573 Zero	
			Vert.	Hor.	Vert.	Hor.
		.10	+.034	+.035	+.056	+.055
		.50	35	37	56	55
		.75	36	37	56	55
		1.00	37	37	55	55
		2.00	37	37	55	55
		3.00	37	37	55	55
		4.00	37	37	55	55
		5.00	37	37	55	55
		6.00	37	37	55	55
		7.00	37	37	55	55
		8.00	37	37	55	55
		9.00	37	37	55	55
		9.50	37	37	55	55
		10.00	+.037	+.037	+.055	+.055
			Chamber Section (Actual Diam.)			
			Y	X		
		10.25	1.631	1.631		
		11.00	1.631	1.631		
		11.50	1.631	1.631		
		11.85	1.631	1.631		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped):
Several very light longitudinal scratches with very light metallic [illegible] [illegible] throughout chamber and bore.

Gauged by
Knape
Cox
Barker

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	
MANUFACTURER	AA
PROOF OFFICER	MR. REELE W.O. 324-329-80
MODEL	
NUMBER OF ROUNDS	BF-APG
NUMBER	17
FIRING STATUS (Check One)	BEFORE ✓ AFTER
	40 M/M Grenade Launcher
DATE OF GAUGING	3 MAY 1968

Distance (Inches) From Muzzle Face	Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.054	+.054
.50	36	36	54	54
.75	36	36	54	54
1.00	36	36	54	54
2.00	36	36	54	54
3.00	36	36	54	54
4.00	36	36	54	54
5.00	36	36	54	54
6.00	36	36	54	54
7.00	36	36	54	54
8.00	36	36	54	53
9.00	36	36	54	53
9.50	36	36	54	53
10.00	+.036	+.036	+.054	+.053
	Chamber Section (Actual Diam.)			
	Y	X		
10.25	1.632	1.632		
11.00	1.632	1.632		
11.50	1.632	1.632		
11.85	1.632	1.632		

Twist of rifling - Uniform - right hand - one turn in 18.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	
MANUFACTURER	AA
PROOF OFFICER MR KEELE	W.O. 324-329-80
MODEL	
NUMBER OF ROUNDS	BF-APG
NUMBER	18
FIRING STATUS (Check One) BEFORE ✓ AFTER	
DATE OF GAUGING 3 MAY 1968	
40 M/M Grenade Launcher	

Station (Inches) From Muzzle Face	Gage Measurements Indicate .XXX" Lands 1.573 Zero Vert.	Hor.	Grooves 1.573 Zero Vert.	Hor.
.10	+.036	+.035	+.054	+.054
.50	36	35	54	54
.75	36	35	54	54
1.00	36	36	54	54
2.00	36	36	54	54
3.00	36	36	54	54
4.00	36	36	54	53
5.00	36	36	54	53
6.00	36	36	54	53
7.00	36	36	54	53
8.00	36	36	54	53
9.00	36	36	54	53
9.50	36	36	53	53
10.00	+.036	+.036	+.053	+.053
	Chamber Section (Actual Diam.)			
	X	Y		
10.25	1.632	1.632		
11.00	1.632	1.632		
11.50	1.632	1.632		
11.85	1.632	1.632		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Boresqoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by: Roope
Moody
McWilliams

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AA
PROOF OFFICER	MC NEELL C.O. 324-329-80
MODEL	
NUMBER OF ROUNDS	BF-APG
NUMBER	20
FIRING STATUS (Check One)	BEFORE ✓ AFTER
DATE OF GAUGING	3 MAY 1968
	40 M/M Grenade Launcher

Distance (inches) From Muzzle Face	Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.035	+.036	+.054	+.054
.50	34	36	54	54
.75	36	36	54	54
1.00	35	36	54	54
2.00	35	36	54	54
3.00	35	37	55	54
4.00	35	37	55	54
5.00	36	37	55	54
6.00	36	36	55	54
7.00	36	36	55	54
8.00	36	36	54	54
9.00	36	36	54	54
9.50	36	36	54	54
10.00	+.036	+.036	+.054	+.054
	Chamber Section (Actual Diam.)			
	X	X		
10.25	1.634	1.634		
11.00	1.634	1.634		
11.50	1.634	1.634		
11.85	1.634	1.634		

Twist of rifling - Uniform - right hand - one turn in 18.00" or one turn in 30 calibers.

Total length of tube - 12.00"
No. of lands - 6

Remarks: (Boresdoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by: Roose
Moody
McWilliams

STEAP-DR Form 106, 17 Jun 64 (Part I)

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AW
PROOF OFFICER HE KELLO W.O. 324-329-80	
MODEL	
NUMBER OF ROUNDS	B.E. 47 APS
NUMBER	AW 02
FIRING STATUS (Check One) BEFORE	✓
FIRING STATUS (Check One) AFTER	
40 M/M Grenade Launcher	
DATE OF GAUGING	2 MAY 1368

Distance (inches) from Muzzle Face	Gage measurements indicated in .1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.035	+.036	+.053	+.054
.50	35	36	53	54
.75	36	36	53	54
1.00	36	36	53	54
2.00	36	36	53	54
3.00	36	36	53	54
4.00	36	36	53	54
5.00	36	37	53	54
6.00	36	37	53	54
7.00	36	37	54	54
8.00	36	37	54	54
9.00	36	37	54	54
9.30	+.036	+.037	+.054	+.054
	Chamber Section (Actual Dia.) X			
9.60	1.630	1.630		
10.00	1.630	1.630		
10.75	1.636	1.636		
11.20	1.642	1.642		

Twist of rifling: - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Borescooed): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by:
Boore
~~Booth~~
~~Moody~~

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	A.N.
PROOF OFFICER MR. KEELE	W.O. 324-329-80
MODEL	
NUMBER OF ROUNDS	1045
NUMBER	A102
FIRING STATUS (Check One) BEFORE	
FIRING STATUS (Check One) AFTER	✓
40 M/M Grenade Launcher	
DATE OF GAGING	8 August 1968

Gaged by
Roope
Cox
Barker

Distance (Inches) from Muzzle Face	Case measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.054	+.054
.50	36	36	54	54
.75	36	36	54	54
1.00	36	36	54	54
2.00	36	36	54	54
3.00	36	36	54	54
4.00	36	37	54	54
5.00	36	38	54	54
6.00	38	38	54	54
7.00	38	39	54	54
8.00	39	39	54	54
9.00	39	39	54	54
9.30	+.039	+.039	+.054	+.054
	Chamber Section (Actual Dia.)			
9.60	1.630	1.630		
10.00	1.630	1.630		
10.75	1.636	1.636		
11.20	1.643	1.643		

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Borescoped):
Drive is very light longitudinal scratches
with very light metallic and
thru-out chamber. endurance.

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

40 M/M Grenade Launcher	
CASTING NUMBER	X
MANUFACTURER	A. N.
PROOF OFFICER	MR KEALY LT. O. 324-329-20
MODEL	
NUMBER OF ROUNDS	13 AT APG.
NUMBER	AL 03
FIRING STATUS (Check One)	BEFORE ✓ AFTER
DATE OF GAUGING	2 MAR 1965

Distance (Inches) from Muzzle Face	Gage measurements indicated — 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.053	+.054
.50	36	37	53	54
.75	36	37	53	54
1.00	35	37	54	54
2.00	35	36	54	54
3.00	35	36	54	54
4.00	35	36	54	54
5.00	36	36	54	54
6.00	36	36	54	54
7.00	36	36	54	54
8.00	36	36	54	54
9.00	36	36	54	54
9.30	+.036	+.036	+.054	+.054
	Chamber Section (Actual Dia.)			
	X	Y		
9.60	1.630	1.630		
10.00	1.630	1.630		
10.75	1.635	1.635		
11.20	1.642	1.642		

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Borescoped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by :
Roope
Booth
Moody

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER:

MANUFACTURER: A.N.

PROOF OFFICER MA. Heede W.O. 324-329-80

MODEL: 40 M/M Grenade Launcher

NUMBER: ANO3

FIRING STATUS (Check One): BEFORE ☐ AFTER ☑

NUMBER OF ROUNDS: 1040

DATE OF GAUGING: 8 August 1968

Distance (inches) from Muzzle Face	Gage measurements Engraved in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.055	+.055
.50	36	36	55	55
.75	36	36	55	55
1.00	36	36	55	55
2.00	36	36	55	55
3.00	36	37	55	55
4.00	36	37	55	55
5.00	37	37	55	55
6.00	38	38	55	55
7.00	38	38	55	55
8.00	38	37	55	55
9.00	39	39	55	55
9.30	+.039	+.039	+.055	+.055
	Chamber Section (Actual Dia.)			
	Y			
9.60	1.630	1.630		
10.00	1.630	1.630		
10.75	1.635	1.635		
11.20	1.642	1.641		

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped):
Several very light longitudinal scratches with very light [illegible] and at 4 places thru-out chamber and bore.

Gaged by
Scope
Copy
Barrel

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

40 M/M Grenade Launcher	
DATE OF GAUGING	2 MAY 1968
NUMBER	AN04
FIRING STATUS (Check One)	BEFORE ✓ AFTER
NUMBER OF ROUNDS	8.5 MT APG
MODEL	
MANUFACTURER	A.N.
PROOF OFFICER	MR KEALE W.O. 324-332-80
CASTING NUMBER	

Distance (inches) from Muzzle Face	Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.036	+.036	+.054	+.053
.50	36	36	54	53
.75	36	36	54	53
1.00	36	36	54	53
2.00	36	36	54	54
3.00	36	36	54	54
4.00	36	36	54	54
5.00	36	36	54	54
6.00	36	36	54	54
7.00	36	36	53	54
8.00	36	36	53	54
9.00	36	36	53	54
9.30	+.036	+.036	+.053	+.054

	Chamber Section (Actual Dia.) Y	Chamber Section (Actual Dia.) X
9.60	1.629	1.629
10.00	1.629	1.629
10.75	1.635	1.635
11.20	1.641	1.641

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Borescooped): Several very light longitudinal scratches scattered thru-out chamber and bore. Very light metallic and other deposits thru-out chamber and bore.

Gaged by::
Roope
Booth
Moody

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade launcher 40 m/m

CASTING NUMBER:

MANUFACTURER: AN

PROOF OFFICER MR. REELE W.O. 329-329-80

MODEL:

NUMBER OF ROUNDS B.F. AT ADG, MD.

NUMBER: ANO5

FIRING STATUS (Check One) BEFORE [X] AFTER [ ]

40 M/M Grenade Launcher

DATE OF GAUGING 3 MAY 1968

Distance (inches) from Muzzle Face		Gage measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10		+.032	+.032	+.053	+.052
.50		32	32	53	52
.75		32	32	53	52
1.00		32	32	53	53
2.00		32	32	53	53
3.00		32	32	53	53
4.00		32	32	53	53
5.00		32	32	53	53
6.00		32	31	53	53
7.00		32	31	53	53
8.00		32	31	53	53
9.00		32	31	53	53
9.30		+.032	+.031	+.053	+.053
		Chamber Section (Actual Dia.)			
		Y	X		
1.570"	9.60	1.630	1.630		
BASIC	10.00	1.630	1.630		
FOR	10.75	1.635	1.635		
CHAMBER	11.20	1.643	1.643		

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Borescoped):
VERY LIGHT LONGITUDINAL SCRATCHES WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: RADPE
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AN
PROOF OFFICER A.R. KEELE W.O. 329-329-80	
MODEL	
NUMBER OF ROUNDS	R.F. AT APG, MD
NUMBER	AN06
FIRING STATUS (Check One) BEFORE	X
FIRING STATUS (Check One) AFTER	
DATE OF GAUGING	3 MAY 1968

Distance (inches) from Muzzle Face

Case measurements indicated in 1/1000"

		Muzzle Face	Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
		.10	+.032	+.032	+.053	+.053
		.50	32	32	53	53
		.75	32	32	53	53
		1.00	32	32	54	54
		2.00	32	32	54	54
		3.00	32	32	54	54
		4.00	32	32	54	54
		5.00	32	32	54	54
		6.00	32	32	54	54
		7.00	32	32	54	54
		8.00	32	32	54	54
		9.00	32	32	54	54
		9.30	+.031	+.032	+.054	+.054

Chamber Section (Actual Dia.)

			X	Y
1.590"	BASIC	9.60	1.630	1.630
FOR	CHAMBER	10.00	1.630	1.630
		10.75	1.636	1.636
		11.20	1.643	1.643

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped):
VERY LIGHT LONGITUDINAL SCRATCHES WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: MOORE
WHEELER
BRINKMAN

40 M/M Grenade Launcher

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AN
PROOF OFFICER	MR. KEELE W.O. 324:329-80
MODEL	
NUMBER OF ROUNDS	B.F. AT: APG MD
NUMBER	ANM7
FIRING STATUS (Check One)	BEFORE: X AFTER:
40 M/M Grenade Launcher	DATE OF GAUGING: 3 MAY 1968

Distance (inches) from Muzzle Face	Case measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.031	+.032	+.053	+.053
.50	31	32	53	53
.75	31	32	53	53
1.00	32	32	53	53
2.00	32	32	53	53
3.00	32	32	53	53
4.00	32	32	53	53
5.00	32	32	53	53
6.00	32	32	53	53
7.00	32	32	53	53
8.00	32	32	53	53
9.00	32	32	53	53
9.30	+.032	+.032	+.053	+.053

Chamber Section (Actual Dia.)

		X	Y
1.570"	9.60	1.629	1.629
BASIC	10.00	1.629	1.629
FOR	10.75	1.634	1.634
CHAMBER	11.20	1.642	1.642

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Borescoped):
VERY LIGHT LONGITUDINAL SCRATCHES, WITH LIGHT CARBON AND DEPOSITS THRU-OUT CALIBER AND BORE.

GAGED BY: ROOPE
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AN
PROOF OFFICER	MR. KEELE W.O. 324-329-80
MODEL	
NUMBER OF ROUNDS	B.E. AT APG MD
NUMBER	AN08
FIRING STATUS (Check One) AFTER	
FIRING STATUS (Check One) BEFORE	X
	40 M/M Grenade Launcher
DATE OF GAUGING	3 MAY 1968

Distance (inches) from Muzzle Face	Case measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.032	+.032	+.053	+.053
.50	32	32	53	53
.75	32	32	53	53
1.00	32	32	53	53
2.00	32	32	53	53
3.00	32	32	53	53
4.00	32	33	53	53
5.00	32	32	53	53
6.00	32	32	53	53
7.00	32	32	53	53
8.00	32	32	53	53
9.00	32	32	53	53
9.30	+.032	+.032	+.053	+.053

Chamber Section (Actual Dia.)

		X	Y
1.570" BASIC FOR CHAMBER	9.60	1.630	1.630
	10.00	1.630	1.630
	10.75	1.635	1.635
	11.20	1.643	1.643

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescooed):
VERY LIGHT LONGITUDINAL SCRATCHES, WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: ROOPE
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

40 M/M Grenade Launcher

Field	Entry
Casting Number	X
Manufacturer	A.N.
Proof Officer	Mr. Keele W.O. 324-329-80
Model	
Number of Rounds	1043
Number	AN08
Firing Status (Check One)	After X / Before
Date of Gauging	9 August 19[illegible]

Grenade Launcher

Distance (inches) from Muzzle Face	Gage measurements indicated in 1/1000" — Lands 1.573 Zero — Vert.	Lands Hor.	Grooves 1.573 Zero — Vert.	Grooves Hor.
.10	+.032	+.032	+.055	+.054
.50	32	32	55	54
.75	32	32	54	54
1.00	32	32	54	54
2.00	32	32	54	54
3.00	32	33	54	54
4.00	32	33	54	54
5.00	32	34	54	54
6.00	33	34	54	54
7.00	34	34	54	54
8.00	34	34	54	54
9.00	34	34	54	54
9.30	+.034	+.034	+.054	+.054

Chamber Section (Actual Dia.)

Distance	Y	
9.60	1.630	1.630
10.00	1.630	1.630
10.75	1.639	1.638
11.20	1.642	1.642

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped): [illegible] very light longitudinal scratches with very [illegible] and other deposits [illegible]

Gauged by Roger Cox Kikke[illegible]

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

40 M/M Grenade Launcher	
DATE OF GAUGING	7 MAY 1968
NUMBER	AN09
FIRING STATUS (Check One)	BEFORE: X AFTER:
MANUFACTURER	AN
MODEL	
NUMBER OF ROUNDS	B.F. AT ARSENAL
CASTING NUMBER	
PROOF OFFICER	AIR. REELE W.O. 329-329.80

Case measurements indicated ..... 1/1000"

Distance (inches) from Muzzle Face	Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10	+.032	+.032	+.053	+.053
.50	32	32	53	53
.75	32	32	53	53
1.00	33	33	53	53
2.00	33	33	53	53
3.00	33	33	53	53
4.00	33	33	53	53
5.00	33	33	53	53
6.00	33	33	53	53
7.00	33	33	53	53
8.00	33	33	53	53
9.00	33	33	53	53
9.30	+.033	+.033	+.053	+.053

Chamber Section (Actual Dia.)

		X	Y
1.570" BASIC	9.60	1.631	1.631
LOC	10.00	1.631	1.631
CHAMBER	10.75	1.635	1.635
	11.20	1.612	1.612

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped): VERY LIGHT LONGITUDINAL SCRATCHES, WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: ROOPE
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER:

MANUFACTURER: AN

PROOF OFFICER NIR. KEELE W.O. 324-329-80

MODEL:

NUMBER OF ROUNDS: B.F. AT APG MD

NUMBER: ANIO

FIRING STATUS (Check One): BEFORE X AFTER

40 K/M Grenade Launcher

DATE OF GAUGING: 3 MAY 1965

Case measurements indicated in 1/1000"

Distance (inches) from Muzzle Face			Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
		.10	+.021	+.032	+.053	+.053
		.50	31	32	53	53
		.75	31	32	53	53
		1.00	31	32	53	53
		2.00	31	32	53	53
		3.00	32	32	54	53
		4.00	32	32	54	53
		5.00	32	32	54	53
		6.00	32	32	54	53
		7.00	32	32	54	53
		8.00	32	32	54	53
		9.00	32	32	54	53
		9.30	+.032	+.032	+.54	+.53
			Chamber Section (Actual Dia.)			
	1.570"	9.60	1.630	1.630		
	BASIC	10.00	1.630	1.630		
	FOR	10.75	1.635	1.635		
	CHAMBER	11.20	1.640	1.640		

Twist of rifling - Uniform, right hand, one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped):

VERY LIGHT LONGITUDINAL SCRATCHES WITH CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BASE.

GAGED BY: ROOF
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER: X

MANUFACTURER: AN

PROOF OFFICER MR. KEELE W.O. 324-329-80

MODEL: B.E. AT APS-NIJ

NUMBER OF ROUNDS:

NUMBER: AN II

FIRING STATUS (Check One): BEFORE X; AFTER

DATE OF GAUGING: 3 MAY 1968

40 M/M Grenade Launcher

Distance (inches) from		Muzzle Face	Case measurements Increments of 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
		.10	+.031	+.031	+.053	+.053
		.50	31	31	53	53
		.75	31	31	53	53
		1.00	31	31	53	53
		2.00	31	31	53	53
		3.00	31	32	53	53
		4.00	31	32	53	53
		5.00	31	32	53	53
		6.00	31	32	53	53
		7.00	31	32	53	53
		8.00	31	32	53	53
		9.00	31	32	53	53
		9.30	+.031	+.032	+.053	+.053
			Chamber Section (Actual Dia.) X	Y		
	1.570"	9.60	1.630	1.630		
	BASIC	10.00	1.630	1.630		
	FOR	10.75	1.636	1.636		
	CHAMFER	11.20	1.642	1.642		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"
No. of lands - 6

Remarks - (Boroscoped):
VERY LIGHT LONGITUDINAL SCRATCHES WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: ROOPE
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher

CASTING NUMBER	X
MANUFACTURER	AN
PROOF OFFICER	MR. REELE W.O. 334-324-80
MODEL	
NUMBER OF ROUNDS	8, E, AT A 26 MD.
NUMBER	AN 12
FIRING STATUS (Check One) BEFORE	X
FIRING STATUS (Check One) AFTER	
40 M/M Grenade Launcher	
DATE OF GAUGING	3 MAY 66

Distance (inches) from Muzzle Face		Case measurements indicated in .1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10		+.031	+.032	+.053	+.053
.50		32	32	53	53
.75		32	32	53	53
1.00		32	32	53	53
2.00		32	32	53	53
3.00		32	32	53	53
4.00		32	32	53	53
5.00		32	32	53	53
6.00		32	32	53	53
7.00		32	32	53	53
8.00		32	32	53	53
9.00		32	32	53	53
9.30		+.032	+.032	+.053	+.053
		Chamber Section (Actual Dia.) X	Y		
	1.570"	9.60	1.629	1.629	
	RAISE	10.00	1.629	1.629	
	FOR	10.75	1.634	1.634	
	CHAMBER	11.20	1.640	1.640	

Twist of rifling - Uniform- right hand- one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped):
VERY LIGHT LONGITUDINAL SCRATCHES WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: ROOPE
WHEELER
BRINKMAN

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Grenade Launcher 40 m/m

CASTING NUMBER:

MANUFACTURER: AN

PROOF OFFICER MR. KEELE W.O. 324-329-60

MODEL:

NUMBER OF ROUNDS B.F. AT ABS MD

NUMBER: AN 13

FIRING STATUS (Check One): BEFORE X AFTER

DATE OF GAUGING 3 MAY 1965

40 M/M Grenade Launcher

Distance (inches) from Muzzle Face		Case measurements indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
.10		+.032	+.031	+.053	+.053
.50		32	31	53	53
.75		32	31	53	53
1.00		32	31	53	53
2.00		32	31	53	53
3.00		32	32	53	53
4.00		32	32	53	53
5.00		32	32	53	53
6.00		32	32	53	53
7.00		32	32	53	53
8.00		32	32	53	53
9.00		32	32	53	53
9.30		+.032	+.032	+.053	+.053
		Chamber Section (Actual Dia.) Y	X		
1.570" BASIC FOR CHAMBER	9.60	1.630	1.630		
	10.00	1.630	1.630		
	10.75	1.636	1.636		
	11.20	1.642	1.642		

Twist of rifling - Uniform - right hand - one turn in 48.00" or one turn in 30 calibers.

Total length of tube - 11.30"

No. of lands - 6

Remarks - (Borescoped):
VERY LIGHT LONGITUDINAL SCRATCHES WITH LIGHT CARBON AND OTHER DEPOSITS THRU-OUT CHAMBER AND BORE.

GAGED BY: ROOPE (WHEELER BRINKMAN)

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Launcher, Grenade, M79 Master Launcher

CASTING NUMBER	X
MANUFACTURER	—
PROOF OFFICER	Ma. Staley 12 Oct 1984-82 1-72
MODEL	M79
NUMBER OF ROUNDS	100 (Approx)
NUMBER	30827
FIRING STATUS (Check One)	BEFORE / AFTER ✓
DATE OF GAUGING	9 May 1996
	40 M/M Grenade Launcher

Distance (inches) from Rear face of tube	Distance (inches) from Muzzle Face	Gauge meas. indicated in 1/1000" Lands 1.573 Zero Vert.	Lands 1.573 Zero Hor.	Grooves 1.573 Zero Vert.	Grooves 1.573 Zero Hor.
13.85	.15	+.036	+.038	+.055	+.055
13.50	.50	35	37	55	55
13.25	.75	35	36	55	55
13.00	1.00	34	35	55	55
12.00	2.00	34	35	55	55
11.00	3.00	34	34	55	55
10.00	4.00	33	34	55	54
9.00	5.00	33	34	55	54
8.00	6.00	32	34	55	53
7.00	7.00	34	34	55	54
6.00	8.00	34	34	55	54
5.00	9.00	35	35	54	55
4.00	10.00	35	34	54	55
3.00	11.00	35	35	54	55
2.50	11.50	35	34	55	54
2.20	11.80	+.035	+.035	+.055	+.054
		Chamber Section (Actual Diameter)			
		Y	X		
2.00	12.00	1.630	1.631		
1.50	12.50	1.631	1.631		
1.00	13.00	1.631	1.631		
.50	13.50	1.631	1.631		
.20	13.80	cut away	1.631		

Total length of tube- 14"

Number of lands- 6

Remarks (Borescoped): Master Launcher
Very light scratches in chamber with very light deposits in bore.

Twist of rifling - uniform - right hand - 1 turn in approx. 36.00" or 1 turn in 30 calibers.

Gaged by: Wieland, Roope, Gilley

No photos or impressions taken at this time.

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Launcher, Grenade, M79 Master Launcher

CASTING NUMBER	X
MANUFACTURER	-
PROOF OFFICER	Mr. Staley W.O. 324-821-22
MODEL	M79
NUMBER OF ROUNDS	(Approx) 100
NUMBER	30898
FIRING STATUS (Check One)	BEFORE / AFTER X
DATE OF GAUGING	8 Mar 1967
	40 M/M Grenade Launcher

Distance (inches) from		Gauge meas. indicated in 1/1000"			
		Lands		Grooves	
Rear face of tube	Muzzle Face	1.573 Zero Vert.	Hor.	1.573 Zero Vert.	Hor.
13.85	.15	+.036	+.035	+.055	+.056
13.50	.50	36	36	55	56
13.25	.75	35	35	55	55
13.00	1.00	35	35	55	55
12.00	2.00	34	34	55	55
11.00	3.00	34	34	55	55
10.00	4.00	34	34	55	55
9.00	5.00	34	34	55	55
8.00	6.00	33	33	55	53
7.00	7.00	35	35	55	54
6.00	8.00	35	35	55	54
5.00	9.00	35	35	55	55
4.00	10.00	35	36	55	55
3.00	11.00	37	36	55	55
2.50	11.50	36	35	55	55
2.20	11.80	+.035	+.036	+.055	+.054
		Chamber Section (Actual Diameter)			
		Y	I		
2.00	12.00	1.630	1.630		
1.50	12.50	630	631		
1.00	13.00	631	631		
.50	13.50	1.631	631		
.20	13.80	Cut Away	1.631		

Total length of tube- 14"

Number of lands- 6

Remarks (Borescoped): Master Launcher
Very light scratched in chamber with very light deposits in bore.

Twist of rifling - uniform - right hand - 1 turn in approx. 40.00" or 1 turn in 30 calibers.

Gaged by: Wieland, Roope, Gilley

No photos or impressions taken at this time.

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

Launcher, Grenade, M79 Master Launcher

40 MM Grenade Launcher	
NUMBER: 30265	MODEL: M79
FIRING STATUS (Check One): BEFORE / AFTER	NUMBER OF ROUNDS: (Approx) 100
DATE OF GAUGING: 8 May 19-7	PROOF OFFICER: MR. Staley S.O. 324-821-22
	MANUFACTURER:
	CASTING NUMBER:

Distance (inches) from		Gauge meas. indicated in 1/1000"			
		Lands		Grooves	
Rear face of tube	Muzzle Face	1.573 Zero Vert.	Hor.	1.573 Zero Vert.	Hor.
		+.036	+.035	+.056	+.055
13.85	.15	35	35	56	55
13.50	.50	35	35	55	56
13.25	.75	35	35	55	56
13.00	1.00	35	35	55	55
12.00	2.00	35	35	55	55
11.00	3.00	34	33	55	55
10.00	4.00	34	35	55	55
9.00	5.00	34	35	55	55
8.00	6.00	33	34	54	54
7.00	7.00	34	33	55	55
6.00	8.00	35	35	55	55
5.00	9.00	35	35	55	55
4.00	10.00	34	36	54	55
3.00	11.00	34	36	54	55
2.50	11.50	34	36	54	55
2.20	11.80	+.035	+.036	+.054	+.055
		Chamber Section (Actual Diameter)			
		Y	I		
2.00	12.00	1.630	1.630		
1.50	12.50	632	631		
1.00	13.00	632	631		
.50	13.50	1.632	631		
.20	13.80	Cut away	1.631		

Total length of tube- 14"

Number of lands- 6

Remarks (Borescoped): Master Launcher
Very light scratches in chamber with very light deposits in bore.

Twist of ridling- uniform- right hand-1 turn in approx. 40.00" or 1 turn in 30 calibers.

Gaged by: Wieland , Roope, Giley

No shots or impressions taken at this time.

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

40m/m Disposable Barrel

40m/m Disposable Barrel	
NUMBER ----	FIRING STATUS (Check One) BEFORE / AFTER
MODEL ---	NUMBER OF ROUNDS ----
MANUFACTURER -----	PROOF OFFICER Mr. Keele W.O. # 321-329-80
CASTING NUMBER X	
DATE OF GAUGING 14 June 1968	

Distance (inches) From Muzzle Face	Gage Measurements Indicated in 1/1000" Lands 1.573 Basic Diameter Vertical	Horizontal	Grooves 1.618 Basic Diameter Vertical	Horizontal
.10	+.034	+.034	+.054	+.054
.25	34	34	54	54
.50	34	34	54	54
.75	34	34	54	54
1.00	34	34	54	53
1.25	34	34	54	53
1.50	34	34	54	53
1.75	34	34	54	53
2.00	34	34	53	53
2.25	34	34	53	53
2.50	34	34	53	53
2.75	34	34	53	53
3.00	34	34	53	53
3.25	34	34	53	53
3.50	+.034	+.034	+.053	+.052
~~3.75~~				

Number of lands and grooves: 20

Total overall length: 3.62"

Length of rifling: 1.90"

Twist of rifling: Uniform right hand twist-1 turn in 48" or 1 turn in 30 calibers.

Gaged by: Booth
Cox
H. Martin

WATTERS/ss/6616

PROCUREMENT/WORK DIRECTIVE (AMCR 11-16)

1. TRANSMITTAL CONTROL NUMBER: 0038
2. PAGE 1 OF 1 PAGES
3. PRIORITY: 93

4. TO: COMMANDING OFFICER
Aberdeen Proving Grounds, Md. 21005
ATTN: STEAP-CO-R

5. AUTHORIZED BY: ALVIN C. ISAACS, Col, OrdC
Project Manager, Rifles

6. BASIC PART CODE: A165007

7. DATE: 8054 2/23

8. FROM: Project Manager, Rifles, USAWECOM
Rock Island, Illinois 61201
ATTN: AMCPM-RS/AMSWE-CPPG

9. AUTHORIZED BY:

10. PROJECT NO./CATEGORY CODE: 1X542703D345

11. CIC TITLE/ITEM NOMENCLATURE: GLAD

12. CUSTOMER ORDER NUMBER: A1-7-R0001-A1-45

13. PRON: 45-7-73147-(01)-45-E2

14. AMCMS CODE: 5542.12.46601.47

15. ACCOUNTING CLASSIFICATION: 2112040 766-4501 P5542 S11199

16. 8061

17. QUANTITY ON ORDER:

18. TARGET DATE FOR OBLIGATION: 8099

19. LOCAL USE: Ele code 6A1.27.03.1

20. QUANTITATIVE AND CHANGE DATA

ELEMENT	U/M	QUANTITY	UNIT PRICE	TOTAL PRICE
a. PRIOR				
b. TOLERANCE USED				
c. INCREASE				$91,528.00
d. DECREASE				
e. CURRENT		N/A		$91,528.00
f. TOLERANCE				None

21. REPORT CODE: K

22. TYPE OF FINANCING: 3 "Funds Certified"

23. DESCRIPTION OF WORK AUTHORIZED/SPECIAL INSTRUCTIONS/ENCLOSURES: Expiration date: 8366

Program authority is issued to support Engineering Design Tests of the GLAD program.

These tests will begin 1 May 1968 and last approximately 3 months.

Tests will be conducted on three different types of launchers (AAI Pump, Aeronutronics Pivot, and DBCATA). Twelve launchers of each type will be furnished. Tests will be conducted in accordance with the test plan submitted by your agency.

Reference: AMCPM-RS letter, dated 19 Feb 68.
Subject: Funding and time estimates for EE of Grenade Launcher Attachments for M16A1 Rifle

$24,329

The above items and conditions are satisfactory and are accepted as a cost reimbursable project order and will be performed as ordered herein.

Accepting Officer DATE

SEA

24. PACKAGING, PACKING AND MARKING SHALL BE IN ACCORDANCE WITH:

25. DISTRIBUTION PATTERN:

BASIC FACT CODE:

STOCK NUMBER:

a. DEPOT	DOC IDENT	RI FROM	M O S	U/I	QTY	CUST DOC NUMBER	D U P	SUPP'L ADDRESS	S I G	F A C	DIST	PROJ	PD	RDD	A D V	MGT DATA	UNIT PRICE

UNIT PACK: INTER PACK: CONSIGNEE:
P O P LEVEL: PACKING LEVEL:

Q	D	Q	D	Q	D	Q	D	Q	D	Q	D
Q	D	Q	D	Q	D	Q	D	Q	D	Q	D

b. DEPOT	DOC IDENT	RI FROM	M O S	U/I	QTY	CUST DOC NUMBER	D U P	SUPP'L ADDRESS	S I G	F A C	DIST	PROJ	PD	RDD	A D V	MGT DATA	UNIT PRICE

UNIT PACK: INTER PACK: CONSIGNEE:
P O P LEVEL: PACKING LEVEL:

Q	D	Q	D	Q	D	Q	D	Q	D	Q	D
Q	D	Q	D	Q	D	Q	D	Q	D	Q	D

c. DEPOT	DOC IDENT	RI FROM	M O S	U/I	QTY	CUST DOC NUMBER	D U P	SUPP'L ADDRESS	S I G	F A C	DIST	PROJ	PD	RDD	A D V	MGT DATA	UNIT PRICE

UNIT PACK: INTER PACK: CONSIGNEE:
P O P LEVEL: PACKING LEVEL:

Q	D	Q	D	Q	D	Q	D	Q	D	Q	D
Q	D	Q	D	Q	D	Q	D	Q	D	Q	D

AMC FORM 20 OCT 63 1095s

COPY/do

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND S-6 May 68
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BC 2 MAY 1968

SUBJECT: M16A1 Rifle Test Program

Commanding Officer
Aberdeen Proving Ground
ATTN: STEAP-DS

1. References:

a. Letter, STEAP-DS-TI, 27 Dec 67, subj: Draft Plan for Engineer Design Test of 40mm Grenace Launcher Attachment for Rifles, USATECOM Project No. 8-8-0240-09.

b. Message, AMCPM-RS 890, dated 10190Z Jan 68, subj: Funding Estimate for EDT of Grenade Launcher Attachments.

c. Letter, STEAP-DS-TI, 30 Jan 68, with 1st Ind, AMCPM-RD, 20 Feb 68 and 2nd Ind, STEAP-DS-TI, 19 Mar 68, subj: Funding and Time Estimates for Engineer Design Test of Grenade Launcher Attachments for M16A1 Rifle.

d. Letter, AMSTE-BC, 9 Apr 68, with 1st Ind, AMCPM-RD, 23 Apr 68, subj: M16A1 Rifle Test Programs, inclosed.

2. The GLAD test materiel is scheduled to arrive at your installation by 1 May 1968. This test program carries a SEA 02 priority and is of equal importance with other established M16A1 Rifle programs. It is strongly recommended that the capability to support GLAD be reassessed by your command and every effort made to comply with the 1 Aug 68 completion date. Submission of safety release recommendation to this headquarters is required NLT 7 May 68.

3. In accordance with the request of the indorsement to reference 1d, inclosed, CO, APG will plan for and schedule subject tests such that maximum use of manpower and facilities is realized. DBCATA should be included in such scheduling.

COPY/do

AMSTE-BC 12 MAY 1968
SUBJECT: M16A1 Rifle Test Programs

4. If not previously reported in TSMS, submit to this headquarters by 6 May 68 test initiation and completion dates for all assigned M16A1 test programs to include related programs.

5. Additionally, in order to improve responsiveness to subject programs, your comment regarding the feasibility and/or desirability of obtaining contract support by this command is requested.

FOR THE COMMANDER:

1 Incl w/d
AMCPM-RD, 1st Ind,
23 Apr 68, subj as
above

/t/ LeROY S. STANLEY
Colonel, GS
Dir, Inf Mat Test

Copies furnished:
CG USAMC ATTN: AMCPM-RD (w/o incl)
Pres USAIB ATTN: STEBC-SA (w/incl)

APPENDIX III - REFERENCES

1. Plan of Test for Engineer Design of 40-MM Grenade Launcher Attachments for Rifles, 1 May 1968, Distributed by AMCPM-RS. Classified Confidential.

2. Technical Characteristics for 40-MM Grenade Launcher Attachments for Rifles as Approved in the Minutes of Formal In-Process Review Meeting, 18 October 1967, USAMC. Classified Confidential.

3. Summary Report on Evaluation of Patrol Boat, River (PBR) Armament (U). NOLTR No. 67-15, 25 January 1966, United States Naval Ordnance Laboratory, White Oak, Maryland. Classified Confidential.

4. Minutes of Pre-In-Process-Review Meeting Held at AMC Headquarters, 8 July 1968.

AD_____ Accession No._____

Materiel Test Directorate, Aberdeen Proving Ground, Maryland (Formerly Development and Proof Services)
Final Report on USATECOM Project No. 8-8-0240-09, Engineer Design Test of 40-MM Grenade Launcher Attachments for M16A1 Rifle (GLAD) (U), October 1968
RDT&E Project No. 1XS42703D345, Report No. DPS-2929
Authors Eric Keele and George Hendricks
Secondary distribution is controlled by US Army Weapons Command, ATTN: AMCPM-RS.
160 pages, 16 illustrations

Classified Report

This test was conducted primarily to evaluate the characteristics of two prototype 40-mm grenade-launcher attachments for the M16/M16A1 rifle and to determine which was the better design for continued development. One launcher attachment was a pump-action design and the other was a pivot-action design. Additionally, as a portion of a continuing phase of the special-purpose individual weapon (SPIW) program, the 40-mm disposable barrel cartridge area target ammunition (DBCATA) concept was tested concurrently. It was recommended that, of the three launcher designs tested, the design of the pump launcher be considered to offer the more feasible approach toward development of a suitable grenade launcher. It was also recommended that additional R and D efforts to improve the design of the DBCATA launcher be undertaken, if the system is to be further considered.

AD_____ Accession No._____

Materiel Test Directorate, Aberdeen Proving Ground, Maryland (Formerly Development and Proof Services)
Final Report on USATECOM Project No. 8-8-0240-09, Engineer Design Test of 40-MM Grenade Launcher Attachments for M16A1 Rifle (GLAD) (U), October 1968
RDT&E Project No. 1XS42703D345, Report No. DPS-2929
Authors Eric Keele and George Hendricks
Secondary distribution is controlled by US Army Weapons Command, ATTN: AMCPM-RS.
160 pages, 16 illustrations

Classified Report

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Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

Materiel Test Directorate (D&PS)
Aberdeen Proving Ground, Maryland 21005

2a. REPORT SECURITY CLASSIFICATION

[redacted]

2b. GROUP

4

3. REPORT TITLE

ENGINEER DESIGN TEST OF 40-MM GRENADE LAUNCHER ATTACHMENTS FOR M16A1 RIFLE (GLAD) (U)

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report May to August 1968

5. AUTHOR(S) (Last name, first name, initial)

Keele, Eric
Hendricks, George

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
October 1968	160	4

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
Not applicable	DPS-2929
b. PROJECT NO. USATECOM Project No. 8-8-0240-09	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. AVAILABILITY/LIMITATION NOTICES

In addition to security requirements which apply to this document and must be met, it may be further distributed by the holder only with specific prior approval of Commanding General, US Army Weapons Command, ATTN: AMCPM-RS.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	USAWECOM

13. ABSTRACT

This test was conducted primarily to evaluate the characteristics of two prototype 40-mm grenade-launcher attachments for the M16/M16A1 rifle and to determine which was the better design for continued development. One launcher attachment was a pump-action design and the other was a pivot-action design. Additionally, as a protion of a continuing phase of the special-purpose individual weapon (SPIW) program, the 40-mm disposable barrel cartridge area target ammunition (DBCATA) concept was test concurrently. The testing consisted of velocity, accuracy, reliability, adverse conditions, reggedness, and lubricants compatibility tests. Testing began in May and was completed in August 1968. It was found that, on an over-all test basis, the functioning performance of the pump launcher was superior to that of the pivot and DBCATA launchers. Additionally, it was found that the test launchers, irrespective of type, were detrimental to the functioning performance of the rifle to which attached. The firing of the launcher caused the operating parts of the rifle to recoil out of position, resulting in rifle failures to fire and failures of the hammer to remain seated. On two occasions, the latter condition caused inadvertent firing of the rifle when an attached pivot launcher was fired. It was recommended that, of the three launcher designs tested, the design of the pump launch be considered to offer the more feasible approach toward development of a suitable grenade launcher. It was also recommended that additional R and D efforts to improve the design of the DBCATA launcher be undertaken, if the system is to be further considered.

DD FORM 1 JAN 64 1473

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
M16A1 rifle Grenade attachment, 40-mm Disposable barrel Pump-action attachment Pivot-action attachment Firing test Environmental test						

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USATECOM PROJECT NO. 8-8-0240-09

FINAL REPORT ON ENGINEER DESIGN TEST

OF 40-MM GRENADE LAUNCHER ATTACHMENTS

FOR M16A1 RIFLE (GLAD) (U)

Report No. DPS-2929

CODE SHEET

Code AA = Test items manufactured by AAI Inc., Cockeysville, Maryland.

Code AN = Test items manufactured by Aeronutronics Division of Philco Ford Corporation, 1630 S. State College Blvd, Anaheim, California 92805.

(This code sheet is to be removed from this report when loaned or otherwise distributed outside the Department of Defense.)

SUPPLEMENTARY

INFORMATION

DEPARTMENT OF THE ARMY
U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
ROCK ISLAND, ILLINOIS 61299-7300

REPLY TO ATTENTION OF

SMCAR-ESW (70-1p)

ERRATA 10 SEP 1992

MEMORANDUM FOR Defense Technical Information Center, Attn: DTIC-FDRB, Cameron Station, Alexandria, VA 22304-6145

SUBJECT: Distribution of Technical Reports

1. Unlimited distribution of the following three reports is authorized:

a. Engineer Design Test of 40-mm Grenade Launcher Attachments for M16A1 Rifle (GLAD) AD #393211L, Report #DPS-2929 (encl 1).

b. Product Improvement Test of Modified Leaf Sight for M203 Grenade Launcher [redacted] (encl 2).

c. Product Improvement Test of Quadrant Sight for the M203 Grenade Launcher [redacted].

2. Point of contact is Ron Elbe, SMCAR-ESW-S, DSN 793-6461.

3 Encls
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ERRATA
AD-393211L

D. K. KOTECKI
Chief, Cmbt Spt & Sm Cal Wpn Sys Div

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151.20/14